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NT OF AGRICULTURE

FARMERS' BULLETINS

Nos. 1176-1200

WITH CONTENTS AND INDEX

PREPARED UNDER THE SUPERVISION OF

JOHN L. COBBS, JR.

CHIEF, DIVISION OF PUBLICATIONS



WASHINGTON
GOVERNMENT PRINTING OFFICE
1922

405723

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CONTROL OF THE ROOT, STALK, AND EAR ROT DISEASES OF CORN

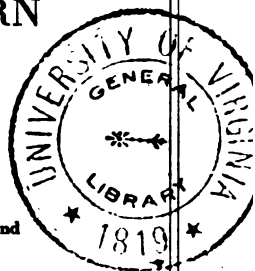
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Reading the Results at the Completion of the Seed-Corn Germination Test

FARMERS' BULLETIN 1176

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Plant Industry

WM. A. TAYLOR, Chief

Washington, D. C.

September, 1920

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THE corn crop in 1919 was worth more than all other cereal crops combined.

The rot diseases of the roots, stalks, and ears of corn are widely distributed in this country wherever corn is grown.

They cause heavy losses, particularly in the corn belt. The loss in 1919 is estimated at 125,175,000 bushels, or 4 per cent of the total crop.

These diseases are caused by several organisms and probably by some other contributing factors.

They may be recognized in germination tests and in the fields by certain symptoms and may be largely controlled by the methods described herein.

Select well-matured seed at the proper time from healthy plants. Avoid all leaning or broken plants and all broken ear shanks even if the ears look healthy.

Select about five times as many seed ears as will be needed, to allow for discarding later all ears found to be diseased.

Cure and store the seed ears in a dry, well-ventilated place. Full directions are given in Farmers' Bulletin 1175.

After the seed ears are thoroughly dry, discard all ears with denting that is too rough or with pink, discolored, cracked, or shredded shank attachments, or with moldy, discolored, or starchy kernels.

Make a special germination test of ten representative kernels from each seed ear selected.

Keep for seed only those ears represented on the germinator by ten healthy seedlings, cutting open the ten kernels to make sure they are not rotted, even if the sprout appears to be healthy.

Discard butt and tip kernels. Then shell each ear separately by hand.

In shelling, discard any ears with kernels that are starchy, moldy, or dull in color.

CONTROL OF THE ROOT, STALK, AND EAR ROT DISEASES OF CORN.¹

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IMPORTANCE OF CORN.

CORN is the most important field crop in the United States. Its value is greater than the combined values of wheat, oats, barley, rye, rice, grain sorghums, and buckwheat. Among the cereals it is a "highly productive crop, yielding on the average about twice as much grain, and, including the fodder, over three times as much food per acre as either wheat or oats." On its production depends, to a large extent, our enormous beef and pork industry.

The commercial varieties include dent corn, flint corn, sweet corn, flour corn, and pop corn. While all of these different kinds of corn have been found to be susceptible to rot diseases of the roots and stalks, the statements in this bulletin apply chiefly to the dent varieties grown in the corn belt.

LOSSES CAUSED BY THESE DISEASES.

The rot diseases of the roots, stalks, and ears of corn cause great losses, are widely distributed, have distinct characteristics, and require special control measures.

¹ The investigations on which this bulletin is based were conducted in cooperation with the Department of Botany, Indiana Agricultural Experiment Station, and Funk Brothers Seed Company, of Bloomington, Ill. The destructiveness of these diseases and the necessity of preventing their spread through seed corn was brought to the attention of the Department by Mr. Eugene D. Funk, who had initiated the investigation in Illinois upon his own farms.

The most careful estimates possible indicate that these diseases cause greater losses in this country than any others affecting corn. In fact, it is believed that they cause greater damage than all the other corn diseases, smut, rust, brown-spot, etc., combined. The losses in 1919 were conservatively estimated at 125,175,000 bushels, or 4 per cent of the total crop.

The actual losses caused by these rots in the corn-belt States can not be accurately estimated. If it were possible to determine the losses caused by poor stands resulting from planting infected seed and also the losses due to the stunting of the growth of the many remaining plants, with the consequent reduced size of ears, it is believed that the total would be fully 10 per cent and perhaps more.

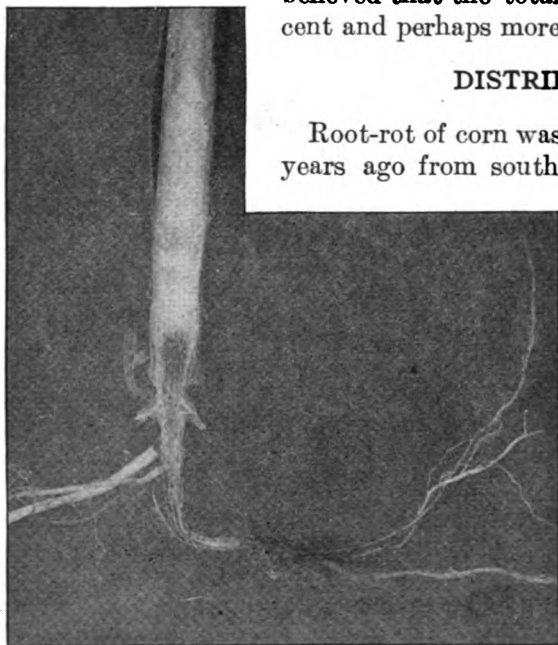


FIG. 1.—Diseased corn seedling, showing blackened roots and kernel and discolored inner tissues of stem.

DISTRIBUTION.

Root-rot of corn was first reported about 15 years ago from southern Ohio, where it was causing marked losses. Later it was reported from Iowa, Nebraska, Illinois, Missouri, and Minnesota. During the last two years (1918–19) it has been found in all of the corn-growing States.

While these diseases have been found to some extent practically wherever corn is grown in this country, they seem to be most destructive in

the corn belt. It is in this section that the most extensive investigations have been carried on, particularly in Illinois and Indiana, and it is to this section that statements in this bulletin are most directly applicable.

In the Southern States the frequent return of corn to the same field in the rotation, and the less common use of the germination test both tend to make the disease abundant.

These rot diseases cause the heaviest losses in dent corn, because this is the commercial corn crop of this country. Sweet corn and flour corn, however, seem to be more severely affected. Not so much disease has been found in flint corn or pop corn where these are commercially grown, this being due, perhaps, in part to less favorable climatic conditions.

CAUSES OF THE ROT DISEASES.

These rot diseases are caused by a number of factors working more or less together, some of which are well known and others less fully known. Investigations have shown that certain fungi,² as well as certain bacteria are commonly present in diseased corn plants in the fields. On the germinator these organisms, as well as certain molds (*Rhizopus*, *Aspergillus*, etc.), also may occur on diseased, weak, or immature kernels and seedlings. These various organisms and other factors are being investigated further in order to learn more definitely the part each plays in causing these diseases.

Sometimes the injuries may be confined to the roots only, but in other cases the same organisms affect the stalks and ears as well. Frequently the injuries to the ears are only very slight. Herein lies much of the difficulty in selecting seed corn, as unless special precautions are taken these infected ears will be used for seed.

The structure of the corn plant is such that the early rotting of the stalk can not be readily observed. The organisms usually enter the base of the stalk while the plant is young and tender. The softer inner tissues are the ones which are first affected, discolored, and disorganized. The hard outer tissues of the stalk prevent the rots from developing rapidly through



FIG. 2.—Diseased corn seedlings, 11 days old, showing infections of varying severity: A, Dead; B, dying; C, moderately diseased, yellowish, and stunted, which may make slow growth and prove barren.

them, and for this reason the changes in the outward appearance of the infected stalks are not very marked at first.

One of the most striking discoveries in this investigation of corn rots is the fact that one of the fungi already mentioned³ is the same fungus that is most commonly the cause of wheat blight or scab. It develops abundantly on old corn stalks and is the most important source of scab infection when wheat follows diseased corn in the rotation.

² Particularly *Gibberella acervalis* (Moug.) Wr. and *Gibberella saubinetii* (Mont.) Sacc. (the latter the cause of wheat scab).

³ *Gibberella saubinetii*.

DESCRIPTION OF THE ROT DISEASES.

The diseases herein described may attack the plant at any stage in its development from the seedling stage to maturity. They produce certain fairly well marked effects (symptoms) that may be recognized in the different stages of growth of the plant. For convenience, the development period of the plant is divided into four parts, namely, the seedling stage, the young-plant stage, the silk-and-tassel stage, and the ear stage.

SYMPTOMS SHOWN IN THE SEEDLING STAGE.

When kernels of corn which are infected by the rot organisms are planted, the conditions in the soil which favor the germination of



FIG. 3.—Healthy corn seedling, the same age and on the same scale as the dead and diseased ones in figure 2.

the seed and the growth of the young seedling also favor the growth and development of the organisms. These organisms may spread directly from the planted kernel into the tissues of the young seedling or through the soil to the growing roots.

Various symptoms may develop as a result of this early injury. The diseased kernels, roots, and lower parts of stalks become rotted and dark colored (fig. 1). These seedlings which are badly infected die very soon after germination (fig. 2, A, B). This manifestation of the disease is known as

seedling blight and is the cause of poor stands in many fields.

Other seedlings which are only slightly affected often partly recover under favorable conditions for growth by pushing out new roots above the affected parts. Such plants may show considerable yellowing and remain stunted. They are handicapped during their early growth, and will not be so productive as those which are not affected. In some cases, the recovery from the seedling infection is so slow that the plants make very little progress during the entire growing season and produce low yields (fig. 2, C). The contrasted appearance of a normal corn seedling is shown in figure 3.

SYMPTOMS IN THE YOUNG-PLANT STAGE.

When the corn is about knee high, or a little higher, diseased fields usually show characteristics similar to fields on poor soils. Where low fertility or poor physical condition of the soil and the disease occur together the diseased condition is more severe. In diseased fields there usually is marked irregularity in the height of the plants (fig. 4). The diseased plants are stunted to varying degrees and frequently are spindling and off color. The lower leaves commonly show considerable dying at the tips. The inside



FIG. 4.—Field of corn showing diseased row at left. Note the lower growth, dwarfed plants, and missing hills, as contrasted with the healthy rows at right.

of the base of the stalk usually is discolored and more or less rotted. The early roots may be considerably rotted. New roots may be developed, but they push out rather high up.

Plants affected in any of these ways do not withstand poor growing conditions well. Healthy plants in the same or surrounding fields grow faster and their normal dark-green color is in rather sharp contrast sometimes to the lighter green of diseased plants. On hot days in dry weather the diseased plants show a tendency to wilt considerably before the normal plants do (fig. 5).

SYMPTOMS IN THE SILK-AND-TASSEL STAGE.

The diseased plants usually are so delayed in their growth that they do not come into silk and tassel until 5 or 10 days later than the normal plants (fig. 6). As a result, the ears on some diseased stalks may be only partly or not at all pollinated. At this stage some of the diseased stalks may show good color, but some of them may show dying of the tops, including the tassel. The lower leaves also may be fired. Considerable leaning of stalks (fig. 7) may occur at this time, due to the weakened condition of the roots (fig. 8). This becomes more marked later in the season.

SYMPTOMS SHOWN IN THE EAR STAGE.

On healthy plants the ears ripen normally while the stalks and most of the leaves are still green (fig. 9, *A*). At this stage the

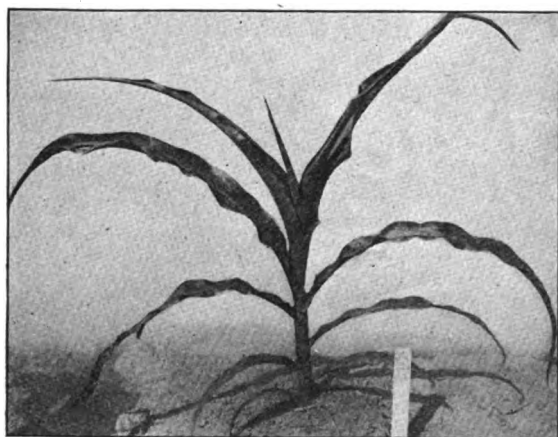


FIG. 5.—Diseased corn plant wilting during hot weather.

diseased plants may be either prematurely dead (fig. 9, *B*) or unduly delayed in ripening. Some of these late-maturing stalks may be barren; others may bear ears of various sizes and qualities, ranging from worthless nubbins to full-sized ears. All such ears are somewhat delayed in ripening. Many diseased stalks will be

either leaning or blown down (fig. 10). This results from the weakened root systems and from the rotting of the stalks themselves.

Many ear shanks on diseased stalks are broken (fig. 11) as a result of rotting. In some cases these ear-shank symptoms also occur on stalks that are otherwise healthy, when infection takes place in the ear shanks or at the butts of ears. Any ear that hangs down on a broken or rotten shank, therefore, is under suspicion, even though it looks fairly good. In some cases the whole ear is rotted or soggy. In other cases it may ripen, but with kernels unnaturally rough, shrunk, or starchy, or rather dull in color.

The results of extensive experiments indicate that the best ears are those that ripen early on good, normal, upright stalks and that remain green while the husks turn yellow to brown and the ears become firm. The best ears usually are not borne perfectly erect, nor do they hang straight down. They are borne on unbroken,

unrotted shanks and show no indications of rotting of the kernels, The kernels of such ears are firm, with dents rather shallow and smooth, and having a bright color.

CONTROL MEASURES.

The best method for the control of these diseases that has been developed to date is to select disease-free seed ears. Diseased ears or even apparently healthy ears from diseased stalks should not be selected for seed. The proper selection of seed corn is no single operation that can be completed within a few days. The different steps that are necessary to obtain the best results are discussed in their order in the paragraphs that follow.

FIELD SELECTION.

SELECT SEED EARS BEFORE FROST.

Field selections of ears of seed corn should be made before the first killing frost. This makes it possible to distinguish between ears that have matured normally (see fig. 9, *A*) and those that have ripened prematurely on account of disease (see fig. 9, *B*). After the first killing frost the stalks and especially the shanks and the ears are invaded rapidly by these disease organisms. Warm weather following the first killing frost favors these ear infections, which greatly reduce the vitality of the seed.

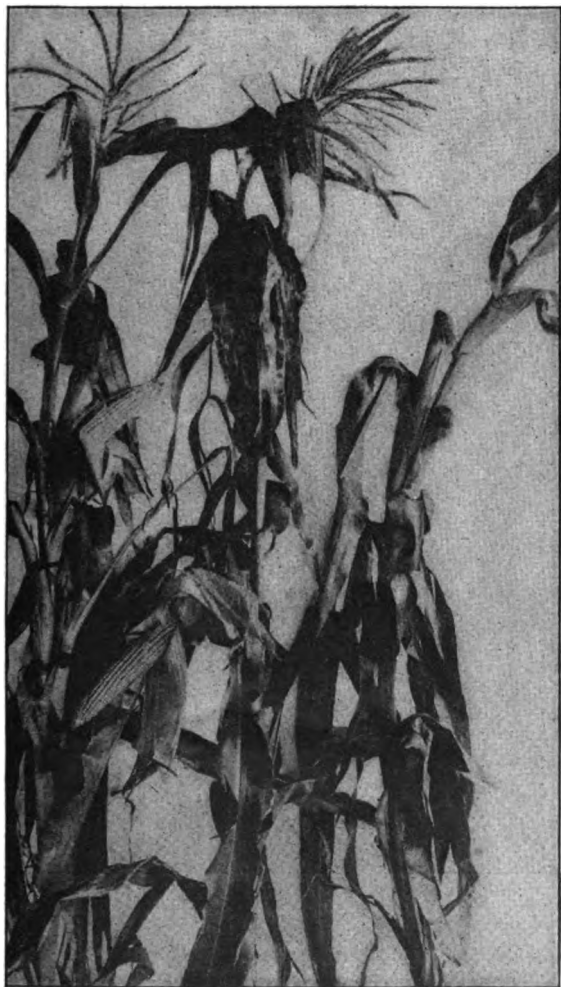


FIG. 6.—Three corn plants of the same age: Normal plant (center) with ears well developed and kernels in dough stage; diseased plants (on either side), the one at the left in the milk stage, the one at the right with silks just out.

SELECT THE BEST NORMALLY MATURED EARS.

Fully matured ears with sound shanks from upright, sturdy stalks have shown, on the average, greater vigor and considerably more resistance to these rot diseases than similar appearing ears from stalks either slightly or badly diseased. Moreover, ears from leaning and broken stalks and ears with slightly rotted shanks from erect stalks are likely to be diseased. Stalks that are wilted and prematurely dead commonly bear diseased ears which are frequently mistaken for early-maturing ones by those not suspecting their



FIG. 7.—Rows of corn, showing healthy plants erect and diseased plants leaning, due to rotted root systems.

diseased condition. Many apparently desirable seed ears droop because of weak, rotten, or broken shanks. Such ears are often diseased. Ears from stalks and shanks showing these symptoms have given greatly reduced yields when planted in experimental plats.

SELECT EARS FROM THE BEST NORMAL STALKS.

As susceptibility to one disease often means susceptibility to other diseases, it is well to avoid ears from smutted or badly rusted stalks. Furthermore, ears from stalks with either rolled, crinkled,

or spotted leaves, or from plants with many fired leaves, also yield less and should not be selected for seed.

QUANTITY OF SEED EARS TO SELECT.

In order to have enough seed ears from which to get the best seed, it is advisable to gather about five times as many as will be required for next year's planting. This will allow for shrinkage, discarded ears, butt-and-tip shelling, grading, etc.

SUMMARY OF RECOMMENDATIONS FOR FIELD SELECTION.

It is best to take only matured ears of medium size from upright plants whose stalks and portions of the leaves are still green and whose ears are supported at a convenient height on strong, sound shanks. (See fig. 9, A.)

CURING AND STORAGE.

The seed ears, after being selected in the field, should be so handled and stored that they will dry uniformly and thoroughly. If the moisture content of the ears remains high, harmful organisms may grow into the ears and infect them. Because of this it is of the utmost importance that the ears be kept in a dry, well-ventilated place. See Farmers' Bulletin 1175 for full directions on curing and storing seed corn.

SUBSEQUENT SORTING OF THE SEED EARS.

After the seed ears have been selected, cured, and stored they should be very carefully sorted during the winter or early spring. Only the very best ears should be retained for seed.

DISCARD OVERSTARCHY EARS AND THOSE THAT ARE TOO ROUGH.

The effects of the rot disease as shown on the roots and stalks are often not severe enough to prevent the development of ears of normal size, but may result in the production of ears that are im-

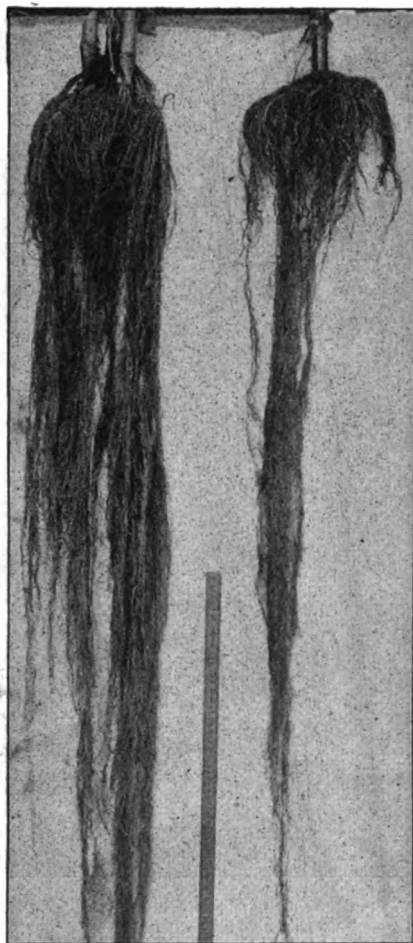


FIG. 8.—Root systems of two corn plants, the one at the left healthy and the one at the right diseased, showing weakened condition.

perfectly matured. The kernels of such ears are more or less starchy and usually have a rougher denting (fig. 12, *B*) in dent corn than fully matured ears (fig. 12, *A*) selected from healthy plants. In many places experimenters and farmers actually have preferred



FIG. 9.—Healthy and diseased corn plants, showing differences: *A*, Healthy, with leaves and stalk green and ear ripe and in normal position; *B*, diseased, with leaves and stalk dead and ear prematurely ripe and hanging from a rotted, broken ear shank.

these rougher and more starchy ears for seed. Frequently such ears are diseased. Plantings from such starchy, immature seed ears have been compared in field experiments with plantings from mature, disease-free seed ears. In the crop from the starchy ears there were more diseased plants, and the acre yield often was as much as 15 bushels less. Ears with very starchy kernels should be eliminated from the seed stock before making germination tests. This is advisable because immature and starchy kernels absorb water more rapidly during germination than the better matured and more horny kernels, and hence the poorer kernels sometimes appear to have a

stronger germination than the good ones. This is especially true when the germination test is read too soon.

DISCARD EARS THAT SHOW ANY EXTERNAL EVIDENCE OF DISEASE.

Most ears having shank attachments pink, slightly pink, or brown colored, or cracked (fig. 13), or shredded (fig. 14) have grown on stalks more or less diseased. Such ears usually are diseased and should be discarded without further examination, regardless of their

good appearance. Ears with tips that have been exposed to the weather before the ears were harvested very frequently are infected at the tip end by organisms washed in from the outside. When the kernels are dull in appearance, slightly brown on the germ side, or somewhat moldy where they have been attached to the cob, it is very likely that the ears are diseased. Discard any such ears before making the germination test.

SELECT THE BEST EARS.

As the result of experiments conducted for a number of years it has been found that the best ears have a bright, shining appearance, indicating complete maturity. The shank attachments are clean and free from any discoloration when freshly cut (see fig. 13, upper



FIG. 10.—Row of corn grown from diseased seed, showing all stalks broken down. Compare adjacent healthy erect rows.

ear). The denting of such ears of dent varieties practically always is shallow to smooth. The kernels are thick and plump, bright and clean in appearance, and have a horny endosperm. The germs are good sized and well developed. When the seed has been carefully selected in the field at the right time and properly stored, it is possible to eliminate a large percentage of the diseased ears and those susceptible to disease by applying these physical methods in the subsequent sorting.

GERMINATOR SELECTION.

The germination test, when conducted carefully and interpreted properly, is a very valuable further aid in the selection of the very best seed ears. By its use, most of the diseased and weak ears which



FIG. 11.—Two ears of corn on rotted, broken ear shanks. Note that one ear looks good enough for seed, but it really is badly diseased.

are not eliminated by physical selections can be detected. A seed stock may be secured thereby that is unusually strong and practically free from disease.

Two methods of testing seed corn are in use. In the first, a table germinator with a limestone-sawdust base is used. In the second method, modified rag dolls are used.

TABLE GERMINATOR.

The table type of germinator is shown in figure 15 and on the title page. It consists of a framework supporting a wire screen on which a 2-inch layer of saw-

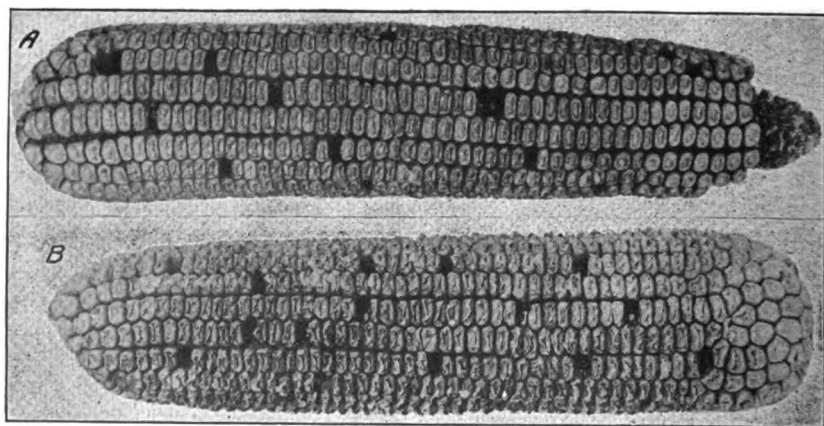


FIG. 12.—Healthy and diseased ears of corn: *A*, Well-matured ear with bright, rather smooth, horny kernels; *B*, diseased ear with dull, rough, starchy kernels.

dust is placed and covered with a layer of agricultural limestone one-fourth of an inch or more in thickness. Limestone protects the germinating seedlings from the effects of the injurious substances which develop in wet sawdust. A sheet of heavy muslin cloth is spread over the limestone and water is sprinkled on the cloth in sufficient quantities to moisten thoroughly all the sawdust. If the sawdust is new, it should be watered frequently for two days before starting the germination test.

Numbers may be painted on the side of the framework at intervals of 10 or 12 inches (see fig. 15), to divide the germination table into blocks by the use of which a record may be kept of the position of kernels from the ears tested. The ears tested in each block may be placed on a near-by rack or in a crate in the same order in which they were placed on the germinator. Ten kernels usually are taken from each ear. They are so arranged on the cloth that each kernel will be at least an inch from any other kernel, and no kernel should be less than 2 to 3 inches from the edge of the germinator. The results may be observed more easily and more accurately when the kernels are placed with the germ sides up and the tips all pointing in the same direction.

After the kernels have been arranged on the tables, they are covered with a sheet of heavy muslin. To prevent rapid drying of the germinator, the cloths are covered with a piece of burlap of the same size, made from medium-heavy gunny sacks. Any other heavy cloth may be used if burlap is not available. When the seedlings on the germinator have sprouts an inch or more in length, the heavier cloths may be removed and the seedlings covered with damp muslin only. Clean, warm water

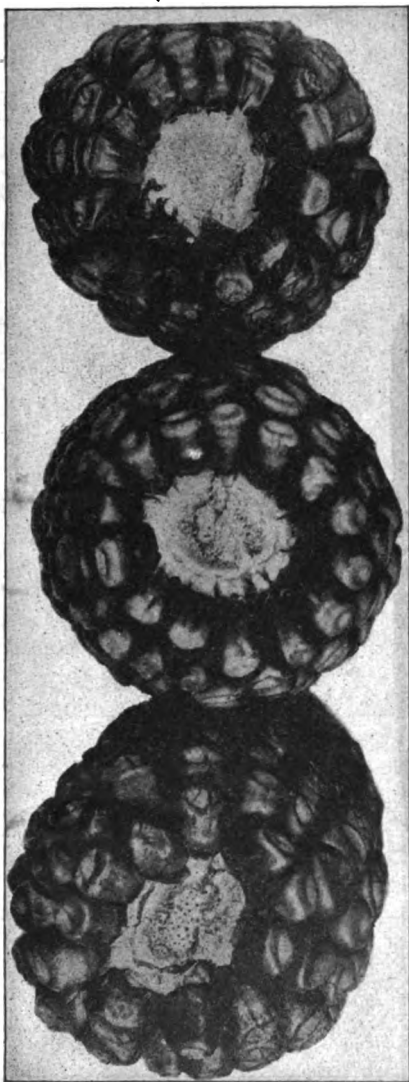


FIG. 13.—Butts of three ears of corn, all of good appearance, but the lower ones showing cracked and discolored shank attachments.

should be sprinkled on the cloths twice a day in sufficient quantities to keep the cloths moist. It is especially desirable to have sufficient moisture at the beginning of the test and to avoid any drying out later. The germinator should be placed in a room where a temperature of 75° to 90° F. and a high humidity can be maintained.

The test is completed and the results recorded when the seedlings have grown to a height of 4 or 5 inches, which requires at least seven days where the temperature averages 85° to 88° F. Where the average temperature is a little lower, that is, from 75° to 80° F., 10 or 12 days may be necessary for the seedlings to reach the desired height.

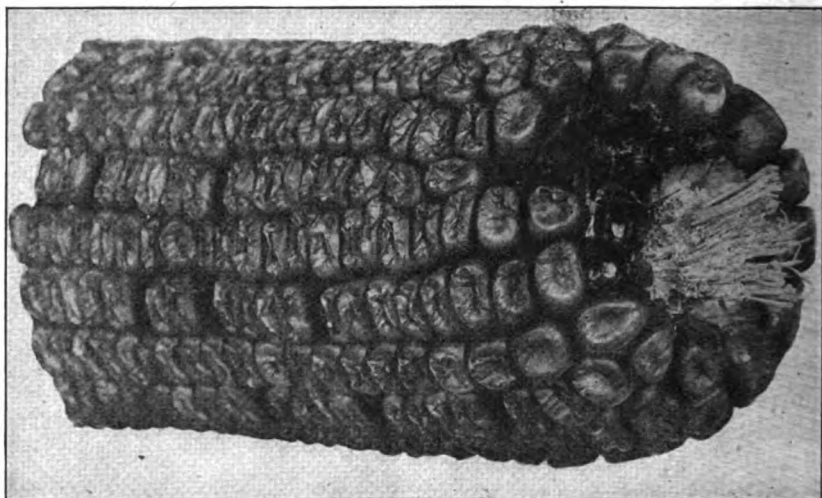


FIG. 14.—Ear of corn showing shredded shank attachment and also somewhat starchy kernels.

Before new cloths are used on the germinator they must be placed in boiling water for at least 15 or 20 minutes, after which they should be rinsed thoroughly. This boiling and rinsing must be repeated before each germination test.

MODIFIED RAG-DOLL GERMINATOR.

The rag-doll germinator has been modified so that diseased kernels can be detected by using it. This method is illustrated in figures 16 and 17. The modified rag doll consists of a muslin cloth 12 by 54 inches long, which has been boiled in water, as indicated for table germinator cloths, and placed on a strip of firm, water-finish fiber paper of equal width and slightly longer (fig. 16).

The kernels from each ear are placed in a row with the germ sides down and with the tips all pointing toward what will be the lower end of the rag doll when it is placed in the germinator box. The cloth is thoroughly wet and then the paper, cloth, and kernels are

carefully rolled up. Rubber bands are placed around each end of the rag doll. The upper end of the rag doll is indicated by attaching a tag bearing the numbers of the ears used and the date of the test.

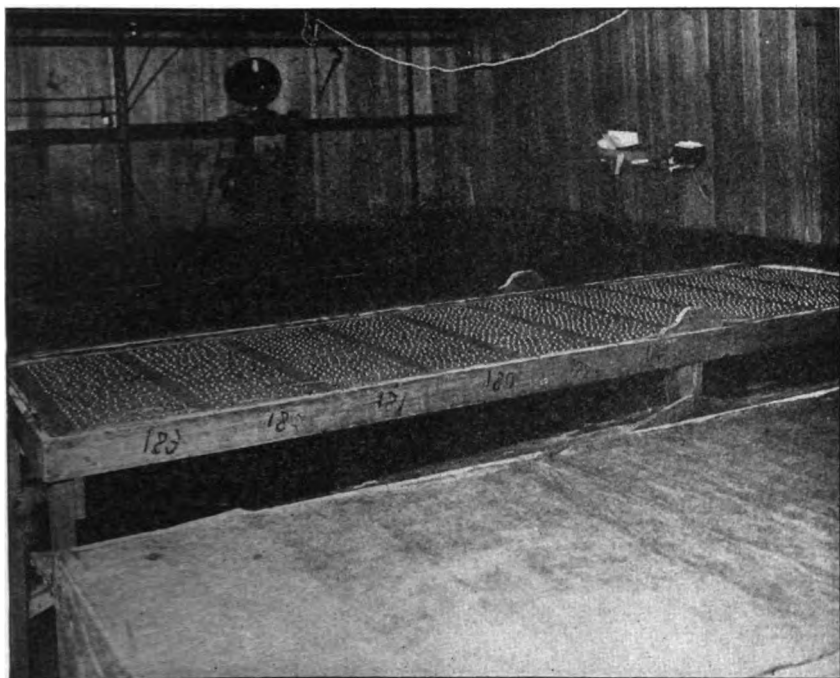


FIG. 15.—Table germinators, one open, the others covered, in the warehouse where many of the seed-corn germination experiments were conducted.

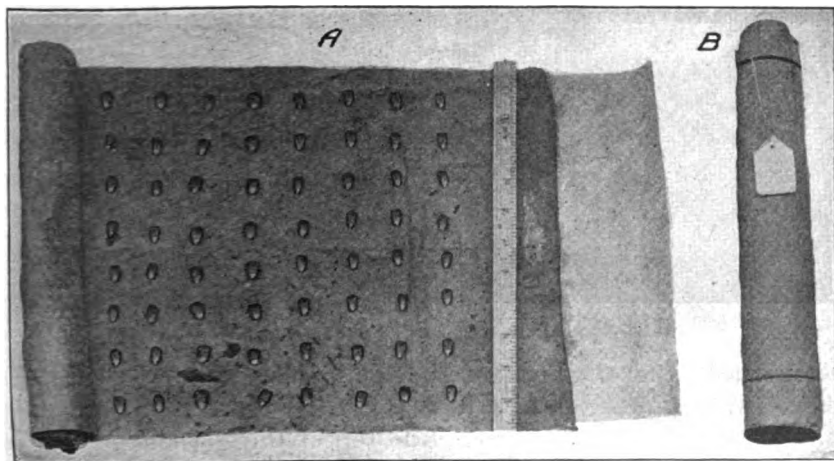


FIG. 16.—Improved rag-doll germinator: A, Open, showing insulating paper, cloth, and corn kernels in position; B, rolled and labeled.

The rag-doll germinators are placed in a box receptacle, as shown in figure 17. This receptacle consists of an outer and an inner box,

with sawdust between them. The inside box may be of any convenient size, but should be at least 18 inches deep. Wire cross rods should be spaced at least 3 inches apart in the upper part of the inner box.

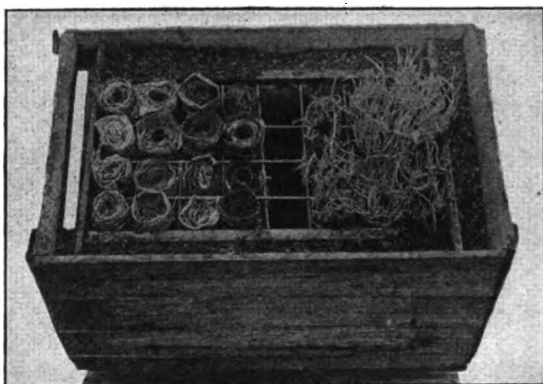


FIG. 17.—Modified rag-doll seed germinators, showing double box with rag dolls in position.

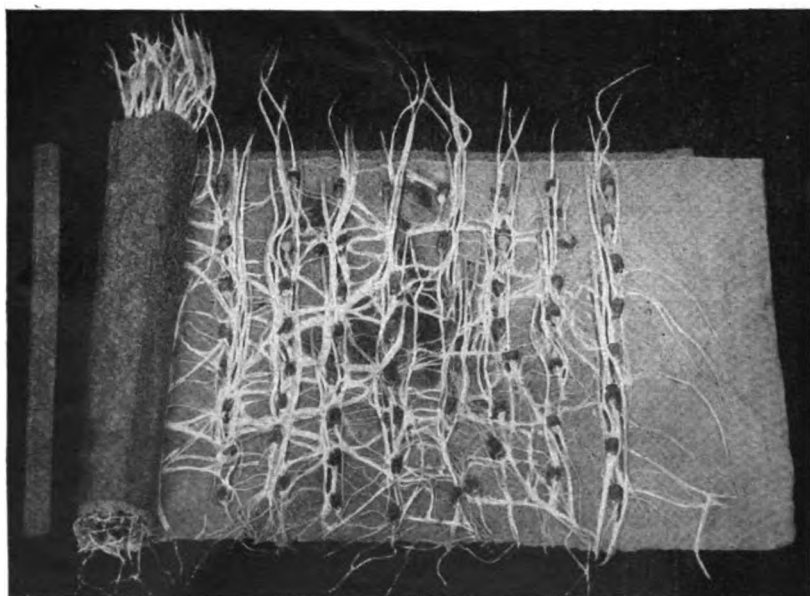


FIG. 18.—Rag-doll germinator unrolled for the reading of results.

The sawdust layer should be at least 2 inches thick between the boxes. When in use the sawdust is kept thoroughly wet and the rag dolls are sprinkled twice daily. The top of the germinator box is kept covered with wet gunny sacks. The box should be kept at a temperature of 75° to 85° F. Where electric current is available this has been satisfactorily accomplished by using electric bulbs under the boxes.

READING THE GERMINATION TEST.

At the end of seven days the rag dolls are ready for readings. They are removed from the germinator box and unrolled (fig. 18). The appearance of apparently healthy and diseased rows of seedlings in the modified rag doll is illustrated in figure 19.

Those seedlings which are rotted, as shown in figures 19 and 20, indicate the ears that are to be discarded. Great care is necessary in reading results on the germinator. Some seedlings which appear healthy grow from kernels rotted on the inside (fig. 21). The only safe practice is to cut open lengthwise all kernels not evidently rotted. (Compare figs. 21 and 22.) Ears represented by seedlings with weak and slender sprouts or short and slender feeder roots (fig. 23) are undesirable for seed and should be thrown out along with those ears represented by rotted seedlings.

The best seed ears of a well-bred strain of corn will produce sprouts like those illustrated in figures 22 and 24. Such seedlings (fig. 24) have thick, sturdy sprouts, an abundance of thick, healthy roots, and show no evidence of rotting when cut open (see fig. 22). The kernels from the best fully matured ears usually remain free from molds, even when the corn has remained on the germinator longer than seven or eight days at a temperature of 85° to 88° F. Those ears should be selected for seed which are represented on the germinator by kernels that all germinate and all show clean, vigorous seedlings, without rotting, like those shown in figures 22 and 24.

SHELLING AND GRADING.

There is considerable advantage in shelling seed ears by hand. Occasionally, ears that have appeared good in all recommended

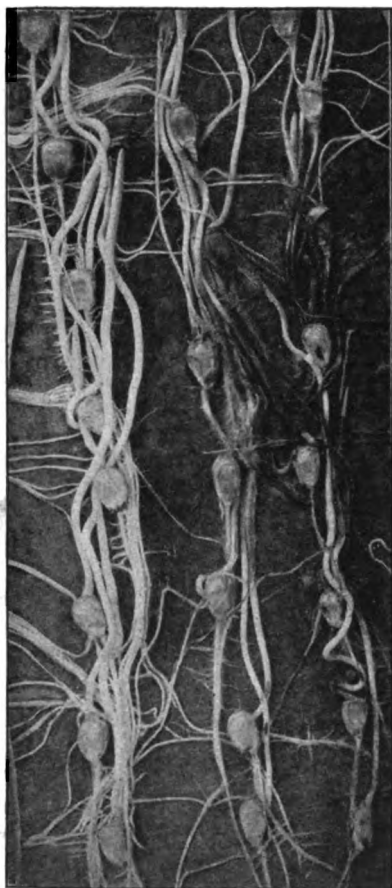


FIG. 19.—Corn seedlings from two diseased ears (right) contrasted with seedlings from a disease-free ear (left). Note the dark areas on the diseased seedlings, showing where the mold is rotting them. The kernels from each ear are laid in a single row in a vertical position, which tends to prevent the lateral spreading of the molds to adjacent rows.

examinations up to this time may finally prove to have starchy kernels (fig. 25) or some badly diseased spots when shelled. By shelling each ear separately into a small pan, the ears having starchy, moldy, discolored, or otherwise suspicious-looking kernels which had not been detected prior to this time may be discarded. There is no cracking or chipping of the kernels when the ears are shelled by hand. This is a distinct advantage when the very best seed is desired.

The best seed corn can not be considered ready for planting until it is properly graded. Careful grading insures a more uniform drop when the proper plates are used in the planter, and this is very essential where an attempt is being made to obtain a uniform stand of vigorous, healthy plants.

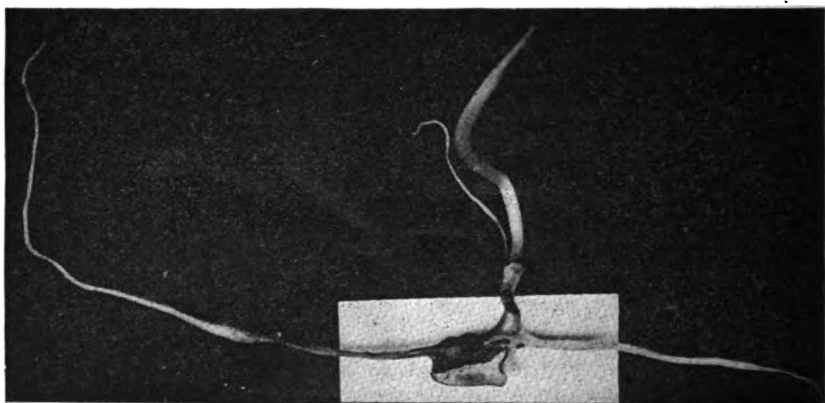


FIG. 20.—Corn seedling severely infected, nearly dead.

BREEDING.

Experimental results indicate that varieties and strains of corn differ widely in their susceptibility and resistance to the rot diseases of roots and stalks. Some strains, derived from the best varieties commonly grown in the corn belt, have shown considerable resistance to these diseases in experimental plats. However, until varieties with greater resistance can be developed, considerable progress in producing higher yields more economically can be made by the selection of the very best seed from the best varieties now available. The continued selection of seed according to the foregoing recommendations has been very effective in improving strains from different varieties.

SOIL RELATIONS.

Intensive investigations have been undertaken recently to determine the influence of different methods of soil management, various soil treatments, and various crop rotations represented in the corn belt on the development of these various rots of corn. The experiments have not been in progress long enough to justify recommenda-

tions for farm practice. However, it is evident that losses caused by these corn diseases are much greater where there is more than 50 per cent of corn in a 4-year rotation. In fields that have been

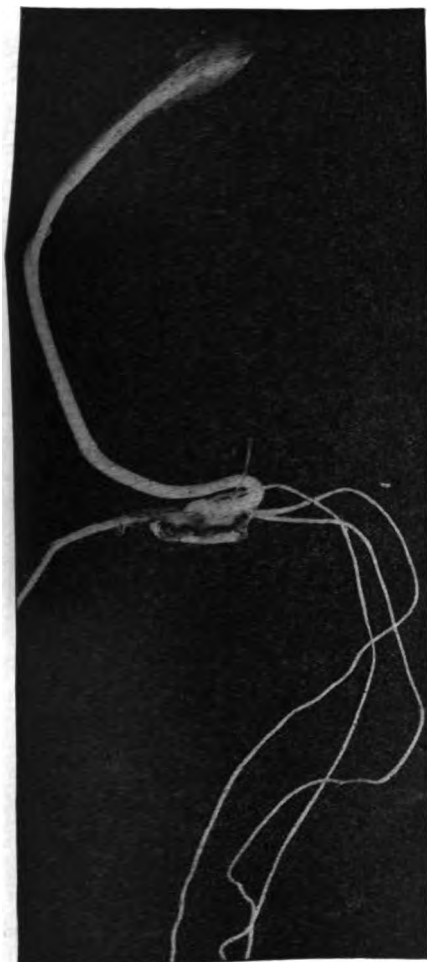


FIG. 21.—Rotted corn kernel discovered only by cutting. The seedling was apparently healthy except for the small number of roots.

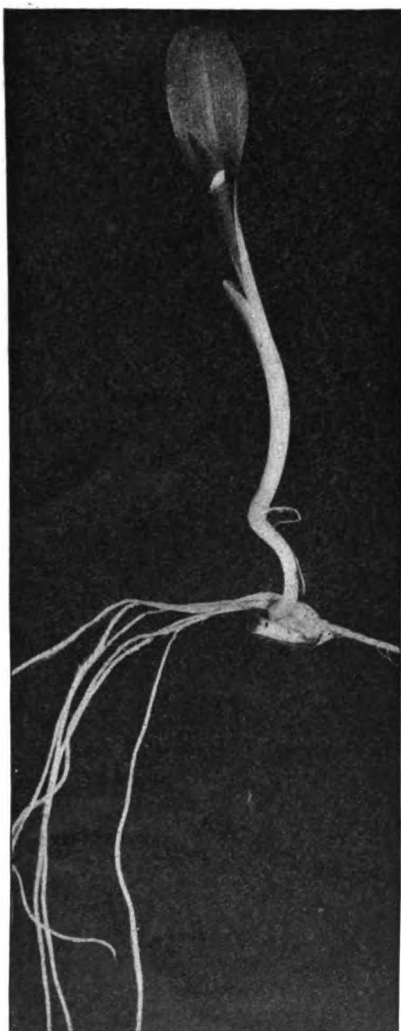


FIG. 22.—Healthy corn seedling produced from a healthy kernel, shown by cutting. Note the numerous strong roots.

cropped to corn continuously for five or more years, it has been almost impossible to find enough plants sufficiently free from disease to permit the selection of desirable ears for seed.

Acid soil reaction, improper physical condition of the soil, lack of essential plant-food materials, and poor drainage are some of the soil

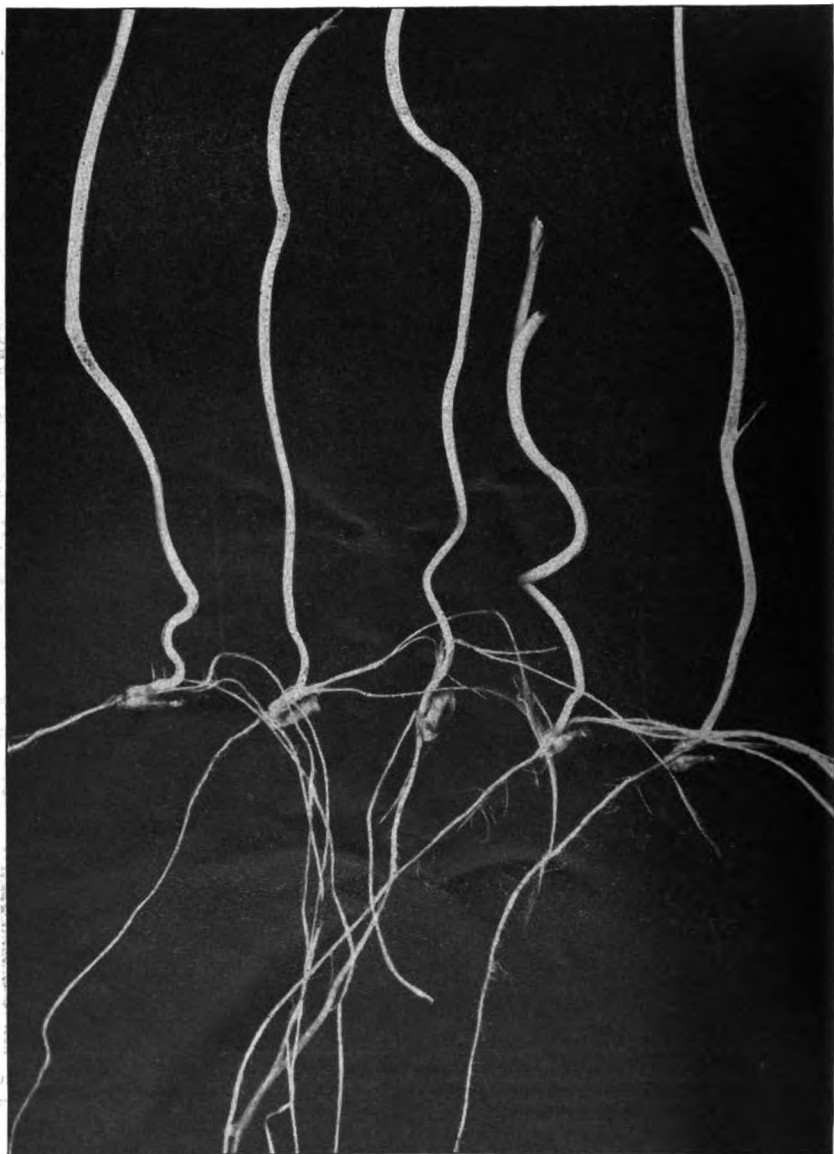


FIG. 23.—Corn seedlings with weak, slender sprouts and roots; not necessarily diseased, but such seed is undesirable because it is susceptible to disease.

factors favoring the development of the corn rots. The correction of soil troubles and the adoption of some approved rotation are very es-

sential steps in reducing losses due to these diseases. However, the occurrence of these diseases is not limited to soils that are faulty in any way. They occur on the very best corn soils. In any case, it is profitable to plant seed as nearly free from disease as possible.

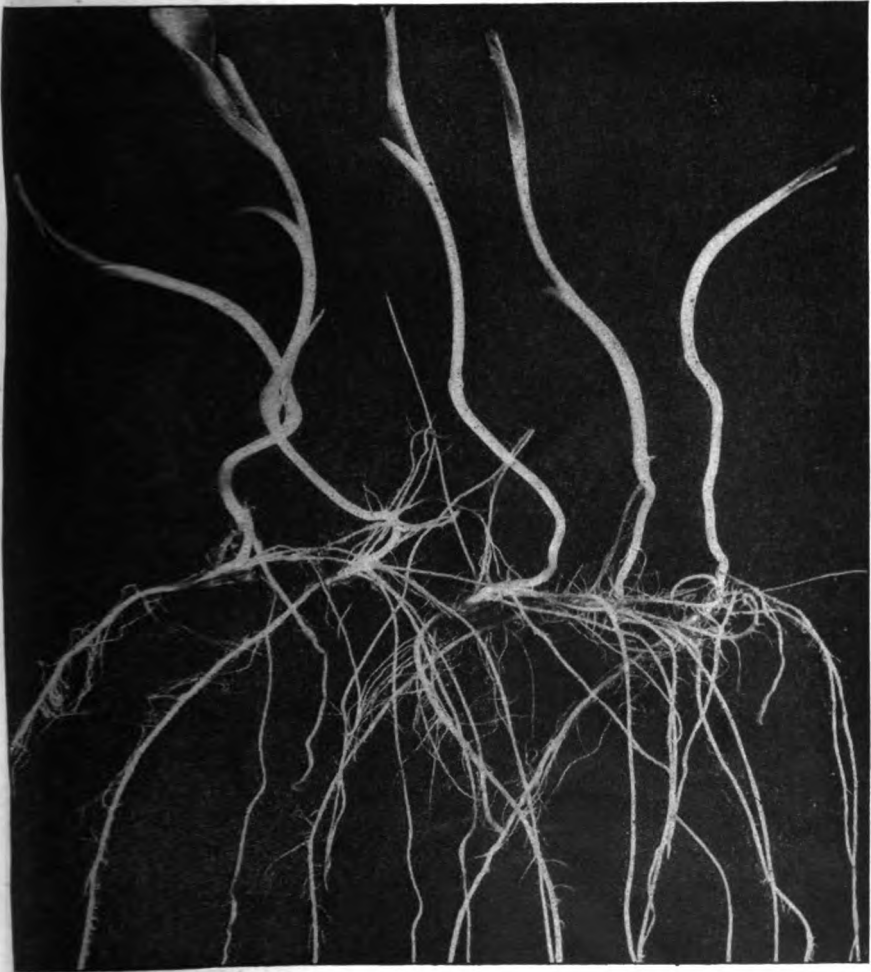


FIG. 24.—Healthy corn seedlings, showing strong vigorous sprouts with numerous strong roots.

CONCLUSIONS.

Seed selected and prepared according to the foregoing recommendations, when planted in competition with average seed, has given better stands, a large percentage of strong, healthy plants, fewer leaning, down, and broken stalks at harvest, and increased yields ranging

from 5 to 30 per cent. Plants from such seed practically always have endured without injury unfavorable weather conditions following planting at the beginning of the normal corn-planting season.

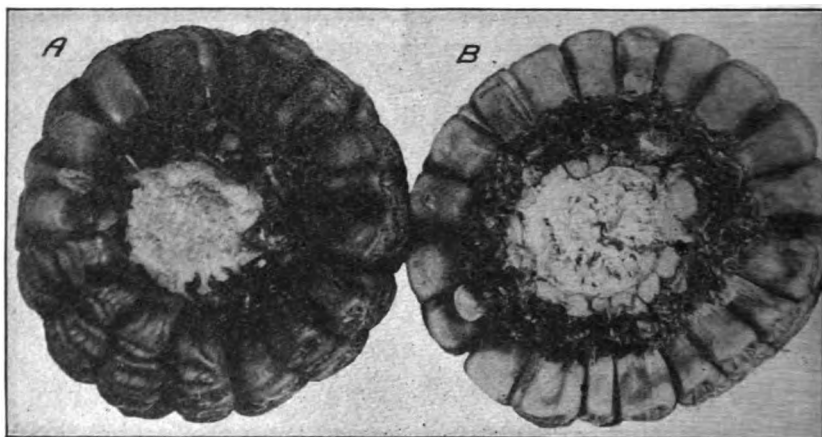


FIG. 25.—Two apparently good seed ears of corn, one of which (B) is found to have starchy kernels when shelled.

Under similar unfavorable conditions seed ordinarily considered good often has either been a failure or produced an unprofitable crop. Experiments carried on during the past three years have shown that it is possible to increase yields from 10 to 15 bushels per acre by the methods recommended in this bulletin.



FARMERS' BULLETIN 1177
UNITED STATES DEPARTMENT OF AGRICULTURE

CARE AND IMPROVEMENT OF THE FARM WOOD



IMPROVEMENT cuttings help the woods in the same way that weeding helps field crops.

Trees grown close enough together in the farm woods so that their tops are in contact produce high-grade saw logs.

Young trees should be coming up in the openings. They should be encouraged by keeping out stock and fire, and by proper cutting methods. Sometimes it is necessary to plant.

In cutting timber take out inferior species to a smaller diameter than the more valuable species and remove *all* defective trees in order to improve the *quality* of the farm woods.

Grass in the woods is a sign that the trees are not close enough together or that the woods are being mis-treated. Pasturing and timber raising on the same area are mutually disadvantageous.

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Contribution from the Forest Service.
William B. Greeley, Forester.

Washington, D. C.

Issued March 22, 1916, revised November, 1920

THE CARE AND IMPROVEMENT OF THE FARM WOODS.

By C. R. TILLOTSON, *Forest Examiner.*

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INTRODUCTION.

THE FARM WOODS furnishes an essential portion of the farm output. Attention given to providing good conditions for the growth of the trees which it contains will pay the farmer well both in comfort and in cash. If properly cared for, the woods will furnish at all times a convenient supply of timber, fuel, fencing, and the like for home use and at intervals will yield valuable material for market. If neglected or abused, it is bound to deteriorate, and may eventually disappear altogether. On farms which have no woods the owner will often find neglected corners or poor-soil slopes where planted trees would be a profitable investment. The most should be made of these, for there are times when wood is as urgently needed as the products of the kitchen garden. The aim of this bulletin is to point out methods of caring for the farm woods and improving it so as to make it contribute as much as possible to both the owner's convenience and his purse.

By far the greater number of farm woods are in need of improvement. Poorer species are in the majority and are crowding out the better ones, many of the trees are overmature, some show evidence of attack by insects or disease, some are dead, young trees are entirely wanting in the open places, and grazing is allowed to the extent of damaging the older trees and preventing reproduction. Improvement of these conditions can be secured through the judicious use of the axe, by assisting natural reproduction, by the exclusion of

stock from at least portions of the woods, and where necessary, through planting or sowing.

TYPES OF WOODS.

There are two general types of farm woods, each of which requires a different method of handling: (1) Those which are characterized by the presence of old trees which dominate the stand, and (2) those which are made up of a nearly even-aged stand of second growth.

(1) Where there are old trees which dominate the stands to a certain extent these old trees may almost totally exclude the younger growth, or they may exist only as a few scattered individuals throughout the stand. Such material is very likely to be deteriorating in quality, and the problem is to remove it, and at the same time provide for a new stand of seedlings. From the standpoint of strict business management timber when mature should be cut just the same as wheat or oats; and usually this is also desirable for the good of the woods itself. No dead or diseased timber should under any circumstances be allowed to stand. The first operation necessary, then, in woods of this type is to cut out at once the dead and diseased material. The second is to cut the mature living trees as soon as sufficient reproduction is started in the openings and marketing conditions permit a satisfactory sale. Heavy stands composed almost wholly of mature trees should not be removed all at once unless the owner expects to provide for the new crop by planting.

In woods where the stand of old trees is not dense and reproduction is already well started, the mature trees should be cut as soon as practicable. Unless removed these will suppress and kill out young trees which would eventually be highly valuable.

(2) Where the woods is made up of a nearly even-aged stand of second growth, trees of undesirable species may predominate and may be crowding out the better ones; or the stand may be overcrowded; or it may be understocked and not reproducing. The improvement of such woods may be brought about by various cuttings, known as "improvement cuttings," and by practices discussed under the heading, "Methods of regeneration."

ESSENTIALS OF A GOOD FARM WOODS.

The woods crop, like any other, should be judged by its quantity and quality. To secure a full stand of trees of high quality, therefore, should be the end sought. Fortunately, the quality of timber is very largely determined by how close together the trees are. To be of high quality, timber must be, to a considerable proportion of its height, free of limbs, which are the cause of knots; it must be tall; and it must not decrease rapidly in diameter from the

butt to the top of the last log. In a dense stand of timber there is considerable competition for sunlight among the individual trees, with the result that height growth is increased. Trees in crowded stands are usually taller than those in uncrowded stands of the same age. When the trees are crowded so that sunlight does not reach the lower branches, these soon die and become brittle; they then fall off or are broken off by the wind, snow, or other agencies. By this process trunks are formed which are free of limbs, and hence of high quality. Further, when trees are crowded their diameters do not decrease rapidly from the butts to the tops. In uncrowded stands just the opposite is true: height growth is usually less; the lower branches continue to live, increase in size, and form large knots; and there is a much greater taper in the trunks of the trees. It is evident, therefore, that trees in the farm woods should be so crowded that the crown or top of each individual tree may be in contact with those of its nearest neighbors. A crowded stand of trees produces not only a larger number but also a greater proportion of high quality saw logs than an uncrowded stand of an equal area. This is of vital importance, because the price of logs of first quality is usually from one and one-half to two times as much as that paid for logs of poor quality.

STOCKING.

The approximate number of trees which should be present per acre is given in Table 1. The figures are applicable to oak, aspen, hickory, elm, and ash, but are from 15 to 20 per cent too low for maple, basswood, yellow birch, beech, and white or red pine. For shortleaf, loblolly, and slash pines the table shows from one-third to one-half the number of trees in well-stocked stands.

TABLE 1.—Number of trees which should be present per acre.¹

Diameter. ²	When diameter of trees ranges from—				When trees are all of a uniform diameter.
	2 to 10 inches.	2 to 14 inches.	6 to 18 inches.	10 to 24 inches.	
Inches.	Trees. ³	Trees. ³	Trees. ³	Trees. ³	Trees. ³
2.....	400	300	.....	.....	2,000
4.....	180	130	.....	.....	900
6.....	105	75	75	.....	510
8.....	65	45	45	.....	320
10.....	50	30	30	30	235
12.....	.....	25	25	20	170
14.....	.....	20	20	16	130
16.....	.....	.....	15	12	100
18.....	.....	.....	12	11	85
20.....	.....	.....	.....	9	75
22.....	.....	.....	.....	8	65
24.....	.....	.....	.....	7	55
Total per acre....	800	625	222	113	.....

¹ Data furnished by Prof. E. L. Sponsler, University of Michigan.

² Diameters taken at 4½ feet from the ground.

³ Of the respective diameters indicated in the first column.

SPECIES.

From the marketing standpoint, some species are preferable to others. Black walnut, white oak, and yellow poplar, for instance, are now of more value than basswood, red gum, or beech. It is probably best, however, to grow those species which will produce the largest amount of material within a specified time rather than to attempt to grow the species most valuable now. This means that trees of the most rapid growth which are well adapted to the region and situation and not subject to serious insect or disease¹ attacks should be favored.

The comparative rates of diameter growth of the most important species for which data are available are about as shown in Table 2. For the rates of growth of individual species in different regions Table 4 (p. 24) should be consulted.

TABLE 2.—Comparative rates of diameter growth of trees.¹

Average number of years to grow 1 inch in diameter.	Species.
2 to 4 years.....	*Cottonwood, black willow, *white willow, *honey locust, *black locust.
3 to 5 years.....	Shortleaf pine, bald cypress, slash pine.
3 to 6 years.....	Red gum, *silver maple, *white elm, yellow poplar, chestnut, *hardy catalpa.
4 to 7 years.....	*White ash, *green ash, *boxelder, *black walnut, white pine, red pine, *butternut, red oak, southern red oak, black oak, *bur oak, aspen, *osage orange, basswood.
5 to 10 years.....	Hickory, white oak, chestnut oak, paper birch, yellow birch, *hard maple, beech.
8 to 10 years.....	Red spruce (second growth).
9 to 18 years.....	Hemlock balsam fir.
18 to 25 years.....	Northern white cedar.

¹ Table is based on growth of trees in plantations (marked with an asterisk) and in natural forest stands (those not so marked).

The slower-growing species, particularly those in the last four lines, will not reach merchantable size as soon as the others, and from an investment standpoint should not be favored in the young growth, provided some of the more rapid-growing kinds will succeed. The value of these slow-growing species for farm purposes, however, will often make it equally desirable to encourage the growth of at least a few of them if the owner wishes material particularly fitted for his own farm uses.

IMPROVEMENT CUTTINGS.

Any cutting designed to remove some of the trees in a stand for the benefit of the remainder is called an "improvement cutting." When made in stands of seedlings or small saplings, such cuttings are

¹ Chestnut is of rapid growth but is subject to such serious disease attack (chestnut blight) that it should be supplanted by other species.

for convenience designated as "cleanings"; when made in somewhat older stands they are known as "thinnings"; when made in stands where scattered old trees are suppressing valuable young growth, they are known as "liberation cuttings."

CLEANINGS.

Often in young stands some of the less valuable species, such as ironwood, threaten to overtop, crowd out, or damage the more valuable species, such as white ash or yellow poplar; sprouts sometimes arise too thickly from the stumps of trees recently cut; or the reproduction of good species is too dense. In any of these cases some of the trees should be removed. Cleanings are nothing more than the weeding out of the poorer species or the poorer individuals where these interfere with the better ones. The practice of lopping the tops of the inferior species rather than cutting them off near the ground level can be followed. These trees will then continue to live, force the growth of the better species, and still continue to shade the ground. Both to decrease costs and to avoid overcutting, only those inferior trees which are actually interfering with the better ones should be removed. The material cut out is usually too small to pay for the expense involved. The justification for cutting it lies in the bettering of the remaining stand.

THINNINGS.

In from 15 to 20 years young stands ordinarily reach a condition which makes the cutting out of some of the trees advisable. By thinning, the stand of trees that is to form the final crop can be regulated and improved. The principle is the same as that applied by truck gardeners or orchardists who thin out their crops to secure the best development of a portion rather than a poor development of the whole. By crowding at the beginning, trees of high commercial quality are produced; but if crowding is allowed to continue after the lower branches die, it will cause stagnation both in diameter and height growth.

The presence of dead or dying trees in the stand, a very dense interlocked crown cover, stems very slender in proportion to their height, or an apparent stagnation in the height growth, indicates that a thinning is needed. Unless the condition of the stand makes earlier thinnings desirable, the best practice is to defer the first one until the product is merchantable and of sufficient size to pay for the operation. Thinnings should be repeated as often thereafter as the material has accumulated in sufficient quantity to pay for the cost. Cordwood and post material will ordinarily be obtained from the first thinnings and larger sized material from the later ones. In

a small woods, thinnings may be carried on by the owner at odd times at no cost other than his own labor. When poles are cut for some farm use, a little care in selecting the trees to be cut will insure a crude form of thinning.

As a rule, trees of the least prospective value should be removed. In any young stand, the trees may be assigned to several classes according to the position of their tops or crowns—dominant, codominant, intermediate, suppressed, and dead. Dominant trees are the tallest ones, whose tops receive almost complete sunlight; codominant trees are those of slightly less height with relatively narrow tops which are not fully exposed to sunlight; intermediate trees are considerably smaller than those of the first two classes, but still healthy because their tops continue to occupy open spaces in the canopy; suppressed trees are those hopelessly behind in height growth and which will either be killed by the shade of the other trees or continue to exist only as stunted individuals. The trees which remain after a thinning should, as a rule, be those which are of the best form regardless of species, the most rapid growing, and presumably of the highest final market value. The trees to be removed should, accordingly, be the dead ones and those of the least valuable and the most slow-growing species in the suppressed and the intermediate classes; but insect and disease infected specimens of all classes should by all means be taken out. To obtain a proper opening of the crown canopy, some of the dominant and codominant trees may also have to be cut. In thinning, it must be remembered that the condition of the soil very much influences the health and vigor of the forest trees. The soil should be kept fresh, soft, loose, and free of a mat of grasses. With field crops, this condition is attained by cultivation. In woods it must be secured by keeping the ground shaded. In making thinnings, therefore, it is desirable to retain any of the intermediate or suppressed trees which are necessary for shading the ground.

The extent to which the crown canopy of a stand may be opened depends largely upon the rate of growth of the trees and their demands for light. In general, openings should not be so large that they will not close again within from three to five years through the growth of the remaining tree tops. In stands of rapid-growing trees, such as cottonwood, yellow poplar, or red gum, the crown canopy of the dominant class of trees can be opened to a greater extent than in stands of slower-growing species, such as white oak, ash, basswood, etc. Definite rules in regard to the amount of material to be removed are not possible for all conditions, but probably not more than from one-fifth to one-fourth of the trees should be removed at a time.

The returns from thinnings will depend largely upon the market for the material removed. If the material is small and suitable only

for a poor class of cordwood, it is quite likely that the product will not pay for the cost of the operation. It must be remembered, however, that the increased growth and value of the remaining product will fully offset this cost. The material taken out in thinnings can accordingly be considered as net gain. Where the market is good, as in parts of the New England States, thinnings have been made at a net profit of from 10 cents to \$2 per cord,² and in one 8-acre woods of white pine in Connecticut thinnings netted the owner \$44.32 per acre.³ When the thinning removes material suitable for posts, handle material, hub stock, small piling, or ties, the operation undoubtedly will pay for itself.

LIBERATION CUTTINGS.

Scattered old trees suppressing valuable young growth will often be found in those woods which have been formed from seeding



FIG. 1.—Well-stocked stand of shortleaf pine thinned from time to time and the product profitably utilized for lumber, ties, and fuel wood.

by adjoining trees of such an area as a worn-out pasture. The first trees to start often have an abundance of room and consequently form very branchy stems and wide spreading crowns. Such trees will never be of much value for lumber and their wide spreading habit often results in the suppression and killing of younger and

² Bulletin No. 2, State Forester's Office, Mass. 1905.

³ "Economic Thinnings of White Pine," Forestry Quarterly, Vol. V, 1907.

better formed seedlings or saplings which ultimately would be of considerable value if the conditions were more favorable. (See fig. 1.) It is best in such cases to remove the old trees at once. A very similar condition is also found in woods which are the remnants of virgin stands. Scattered old virgin trees remain which, through shading, are hindering the growth of younger trees. Often these older trees, because they at one time grew in a dense stand, have a high commercial value. They should be removed as soon as a satisfactory sale can be arranged.

CUTTING OUT OF VINES.

Such vines as grape, ivy, and woodbine sometimes occur in woods and almost invariably twine about the trunks and throughout the tops of the trees. They affect both conifers and hardwoods and often do more damage than may be commonly realized. When of large size, their heavy foliage and small branches shade out and kill the leaves of the trees. Also by their sheer weight alone they often bend over the tops of the trees, which are thus either killed or rendered very unthrifty. (See fig. 2.) The vines themselves have no special value, and they should accordingly be eliminated by severing the parent stem near the ground. It will be best to carry on this operation while the vines are small and before they have done any appreciable damage; and, if lack of time prevents a thorough job, at least the larger ones which it is readily apparent are doing harm should be cut out.

PASTURING OF FARM WOODS.

Pasturing of woods has been one of the chief causes of their deterioration. The severity of the damage depends largely upon the number of stock and the size of the woods. One characteristic of a heavily pastured woods is the almost complete absence of young growth, or its existence only in small ragged patches as broken or scrubby stuff. Cattle, horses, sheep, or goats eat young seedlings, particularly the hardwoods, trample them out, or brush against them and break them off. Hogs eat the seed and thus prevent reproduction from starting, or root young seedlings out of the ground, and sometimes eat the roots. (See figs. 3 and 4.) In those parts of the southern longleaf pine region where hogs run at will, they are known to do a great deal of damage to longleaf pine seedlings and often damage trees several feet in height. When driven out of the swamps by high water in the late winter and early spring, they root up the longleaf pine seedlings and greedily devour the heavy roots. Observations carried on at Urania, La., have shown stands of several thousand longleaf pine seedlings per acre on areas protected against hogs and no seedlings on adjacent areas which were unprotected.

The old growth is damaged through trampling and wounding of the roots and through compacting the soil to such an extent that it is almost impervious to water. Horses sometimes peel the bark from the trees. Old trees show the abuse in the dying of their tops, in a decrease in the amount of foliage, and often in the beginning of decay at the butts. A light cover of grass then makes its appearance and increases the drying out of the soil.

When the crown canopy of a woods is unbroken, and young growth is not desired, a few head of cattle are permissible. They



FIG. 2.—Large spreading tree of poor timber form in center is interfering with thrifty young trees surrounding it and should be cut out.

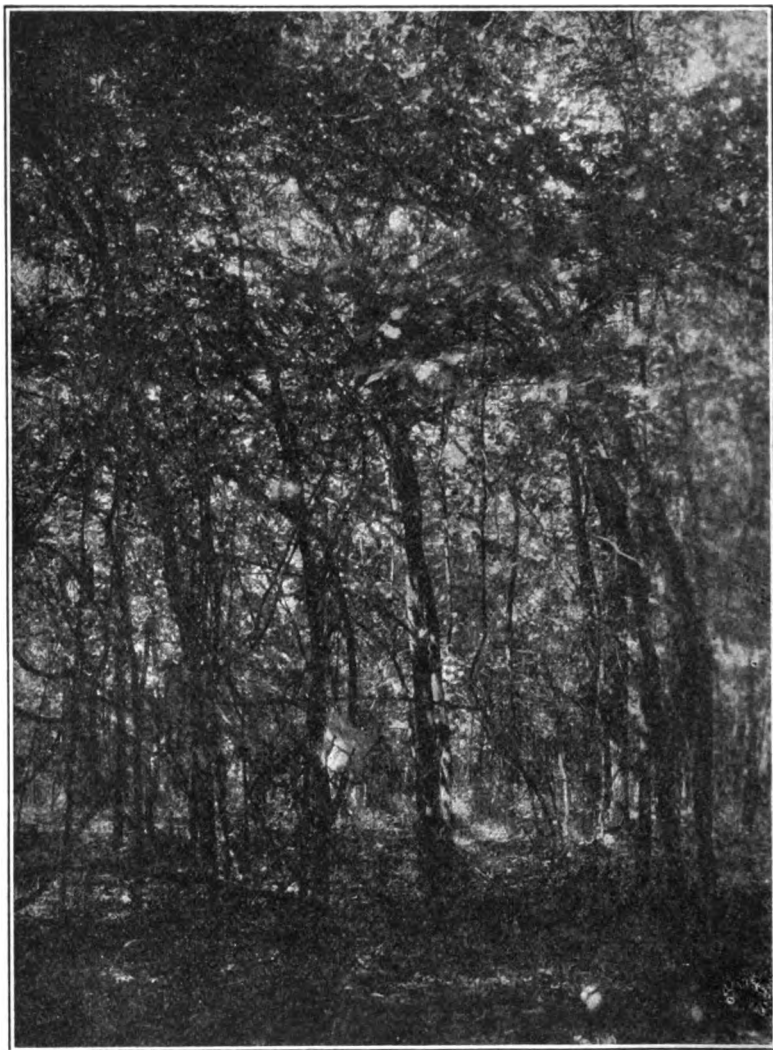


FIG. 3.—Illustrating damage done by grapevines in bending over and finally killing thrifty young trees. Vines should be cut out.

should not, however, be turned in when the ground is very soft—when the frost is going out, for instance, or during a rainy season. The soil is too easily compacted at that time. When it is desired to secure natural reproduction hogs may be turned into the woods shortly before the seed is to fall. They will root up the ground and thus put it in good condition for the reception of the seed. Thereafter, however, they should be kept out.

Goats and sheep should be allowed in the woods only when it is desired to clear up brush of undesirable species, so as to make pos-

sible the reproduction of better ones. If the better species are already present in mixture with the poorer ones, some method of cutting, rather than grazing, should be followed to clear the area of the poorer species. Horses should at no time be permitted in the woods.

Stockmen are quite generally agreed that grass produced under the shade of timber is considerably less nutritious than the same species growing in full sunlight. It is also usually much more sparse. The actual value, then, of woodland pasture is small. Two dollars per acre per year is probably a liberal estimate of the value of the forage. Thrifty fully stocked stands of timber will grow at the rate of 250 or more board feet of lumber per year. Adopting only 250 board feet as the growth and assuming the value of the standing timber to be from \$10 to \$15 per 1,000 feet board measure, the value of the timber growth is from \$2.50 to \$3.75 per acre per year. Stumpage values are sometimes much higher than this, especially if there is considerable white oak, yellow poplar, walnut, or other valuable species in the stand. If the timber is given good care, moreover, the growth should be as much as 500 board feet per acre per year. The larger value of the woods for growing timber, as compared with the value of its forage only, is apparent.

It must not be thought possible to secure this growth of timber and utilize the woods for pasture at the same time. Grass in the woods is almost an infallible indication that the woods is not fully stocked or is being mistreated. Grass will not thrive without strong sunlight, and in a woods in good condition sunlight reaches the forest

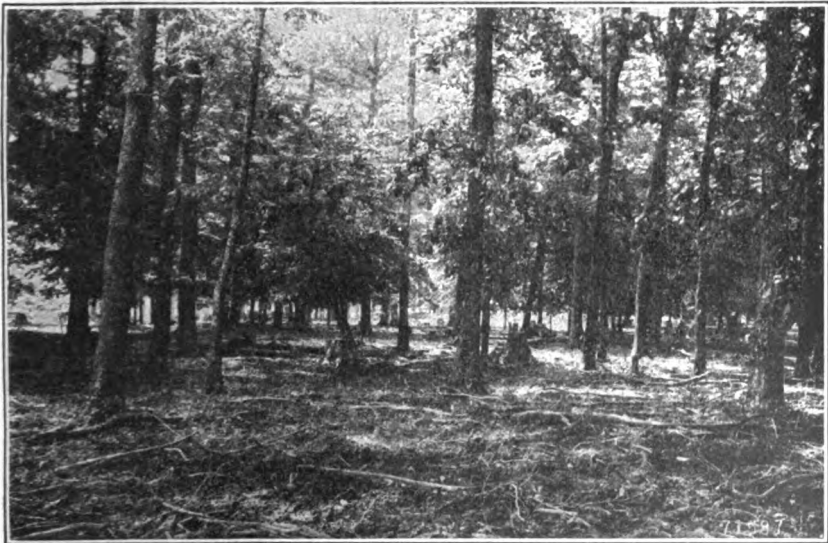


FIG. 4.—Woods in which cattle and hogs have run. No reproduction; roots exposed; results in little growth and a decrease in value of material.



FIG. 5.—A well-managed second-growth woods in Indiana, not grazed. Maximum production of wood.

floor only to a very limited extent. Pasturing and timber production can not, therefore, be practiced on the same area except to the mutual disadvantage of each; and the combination of the two will not pay the owner as well as the practice of either one separately. It must be admitted, however, that the value of the shade to stock may more than offset the loss in timber growth due to the practice of pasturing. Just what this value is, foresters can not say; but to the farmer who pastures his woods and to those interested in timber production as a farm crop, studies looking to the solution of this question would be very helpful in formulating plans for the future. If shade, however, rather than forage is the chief value of the woods to stock, it can doubtless be provided by allowing the stock to range in only a portion of the woodland. The remainder can more profitably be devoted to the production of wood alone.

FIRE PROTECTION.

In the North, because farm woods exist for the most part as small, scattered bodies of timber, which are constantly under the owner's supervision, there need be very little damage from fires. In the South, where farm woods are often of considerable extent, and where it is the very common practice of some people to set the woods afire because of the belief that it improves the grazing, special precautions will need to be taken to keep out fires. It may be possible to plow several furrows around the woods, which will assist in stopping a fire; but perhaps a close watch during the fire season and

vigorous measures to fight fire once started are the best that can be done at present. In addition, an endeavor can be made to arouse public sentiment against setting the woods on fire. Owners are doubtless in some instances indifferent about fires in their woods, because they do not realize that these may do great damage without giving striking evidence of the fact. They burn the fallen leaves and accumulated litter of several years, thus destroying the material with which trees enrich their own soil. The soil becomes exposed, evaporation is greater, and more of the rain and melted snow runs off the surface. The roots may also be exposed and burned. Conditions are such that the vitality of the trees is weakened and their rate of growth decreased. Fires commonly kill a great many of the young seedlings up to 1 inch in diameter. This young stuff is commonly called "brush," but it must be remembered that every large tree was in the "brush" stage once and that the "brush" of to-day will be the large timber trees of the future. Very severe fires kill some of the larger trees and burn through the bark of others. These wounds lower the value of the butt log for lumber, and they afford a ready point of entrance for rot-producing diseases, which often cause deterioration in the quality of the logs for a considerable distance above the wounds. By the entrance of rot the sale value of a tree may easily be decreased by from one-half to two-thirds. Rotten logs are seldom classed as No. 1, and usually as culls. Fires, then, may be expected to destroy the vegetable manure of the forest floor, to kill young growth, to weaken vitality and growth of older trees, and to lower the sale value of timber. Through the killing by fire of the young growth, which permits more light to reach the forest floor, the growth of grass is encouraged and pasturing is probably made somewhat better, but it is believed that, everything considered, the burning of woods to better the pasture does not pay.

INSECTS AND DISEASES.

Damage from either insects or disease is always possible. It is more likely to be serious with some species than with others; and disease is likely to be worse in woods which have been damaged by fire, grazing, lumbering, wind, or any other agency which has served to break the bark or roots and expose the living inner tissues. The damage done by a leaf-eating insect is apparent in the destruction of the foliage. When the insect is one that works under the bark and either bores into or girdles the tree, its presence is manifested by fine sawdust-like particles of wood which fall out of the burrows and collect either around the base of the tree or at the entrance of the burrows. Sap or gum also often exudes from these entrances. When the attack is serious, the leaves of hardwoods change to their

autumnal color, while those of conifers become brown or red. The bark of trees killed by girdling insects becomes loose; and on its inner surface, as well as on the surface of the wood of the tree, there will be found more or less numerous regular wavy passages, or so-called galleries. These are formed by the grubs as they eat their way under the bark. The wood is their food during the course of their development.

The presence of wood-rotting disease is indicated by hollow stems, discoloration, and rot of the wood, and by fruiting bodies. These are the mushroom or bracket-shaped bodies which appear somewhere on the trunk, branches, or roots of the tree, most often at some point where the tree has been wounded. Other types of disease which may seriously damage trees but do not rot the wood may have rather inconspicuous fruiting bodies, but are manifested by an unhealthy appearance of the tree, dying of the branches, distorted twigs or branches, sunken places in the bark, and possibly other indications.

Full information in regard to the damage from either of these sources and the methods of control can usually be secured either from State experiment stations or the United States Department of Agriculture, Washington, D. C.

CARE IN LOGGING.

When the timber in the woods is being cut steps can be taken to insure the perpetuation of the woods and at the same time improve the quality of the stand. Lumbering operations which remove only trees of high quality, such as white oak or black walnut, and leave dead, dying, insect attacked or diseased specimens, and inferior trees, such as beech, should not be practiced. The diseased and dying trees will be a menace to the remaining healthy ones, and the beech, ironwood, dogwood, and other inferior species which remain will scatter their seed over the ground, and very largely make up the future stand. In cutting, therefore, or in selling the standing timber, provision should be made that these inferior species be taken down to a smaller diameter than the more valuable ones and that *all* defective trees be removed. To make such a provision effective, the owner should mark in some manner all the trees which he desires cut or all those which he wishes to retain in his woods. To induce the lumberman to take inferior species and small and defective trees, it may be necessary to make some concessions in regard to price. The trees which remain will be the nucleus of the future crop, and valuable species should be in the majority in sufficient quantities to seed up the cut-over areas.

Unless small trees bring higher prices per unit of measure than large ones, or unless they are of species which it is desirable to elimi-

nate, they should not be cut by the woods owner, nor should he allow lumbermen to cut them. Trees 10 inches and less in diameter cut only very small amounts of low-grade lumber; so that their value is very small. Ordinarily, if they are to be sawed into lumber, the lumberman figures on paying little or nothing for them. He can not afford to do otherwise. Trees of such sizes, however, are usually growing rapidly or will do so when the other trees are removed and they receive more sunlight. As they increase in size, they will cut not only more but higher grade lumber; and they will, accordingly, increase in value in a greater ratio than in size. It is apparent that they should not be cut.

In felling trees, care should be taken not to throw them into the midst of a group of young trees, otherwise these may be seriously broken or bent. Further, by the exercise of a little care when dragging the logs out of the woods, much breakage, bending, and trampling of the young growth, or "brush," can be avoided. It must be kept in mind at all times that this "brush" is the first stage in growth of the mature timber. Every care should be taken to prevent its destruction, particularly in the better species, because it represents an established growth several years in age. A new stand of seedlings may not only be difficult to obtain, but will not have the advantage of this several years of growth. When standing timber is sold, the lumberman should be charged with protecting this young material as fully as possible.

When cutting for his own use, the owner should, so far as possible, observe rules similar to those outlined for lumbering operations. Dead and defective trees can be used for cordwood; the poorer species may sometimes serve nearly as well as the better ones for a special farm need; damage to young growth can be avoided; and the operations can be carried on at such a season of the year and in such a manner as will aid effective sprout reproduction.

METHODS OF REGENERATION.

A very striking condition in by far the greater proportion of farm woods is the absence of small trees. In those few woods which are fully stocked with even-aged trees of relatively even sizes, smaller trees need not be expected nor should their growth be encouraged. Where, however, as is much more commonly the case, the woods is made up partly of mature and partly of decadent trees which should be cut and whose crowns do not fully shade the ground, there should be young trees coming up in the openings. Under normal condition, these young trees would be present, but because of pasturing and fires they do not start. Grass appears instead; and, if pasturing and fires continue, conditions become such that, without

aid, there is little possibility of securing a natural growth of young trees.

NATURAL RESTOCKING BY SEED.

If the woods has not been too badly abused and there is not a heavy sod of grass present, the exclusion of stock and fires will normally result in its restocking itself in time by natural seeding. Good seed years, however, occur only at intervals. Even with a good seed year, the seedling may not be able to get a start because of the sod, the packed condition of the soil, or unfavorable weather. Natural reproduction may, therefore, be very slow, becoming satisfactory in amount only after from 10 to 20 years. It will often be advisable, therefore, when there is a good crop of seed on the trees, to put the ground in such shape as to insure a good crop of seedlings. Before the seed is scattered from the trees in the autumn, the ground can be disk harrowed or cultivated, or hogs can be turned in to root up the soil. The seed will then lodge in the soft earth, where, upon sprouting, the roots may easily take hold. To prevent undesirable species from obtaining a foothold, any trees of such species large enough to bear seed should be cut at the time that pasturing is discontinued.

To secure natural reproduction the old stand will normally have to be removed in two or three cuttings, each taking from one-third to one-half of the trees. The first cutting is designed to open up the crown cover somewhat, so that the leaves on the forest floor may decompose more rapidly, the mineral soil become exposed, and the germination of seed be more certain. The remaining trees become more windfirm, and as a result of their crowns receiving more sunlight they produce more seed. When the forest floor is in good condition the second cutting can be made during the winter following a heavy seed year. With the removal of these trees the conditions will be favorable for the germination of the seed and growth of the seedlings. Neither of the first two cutting should be so heavy that enough light will reach the ground to encourage a heavy growth of weeds or grass. The third cutting should be made after the seedlings are well established and no longer in need of the protection of the old trees.

REGENERATION BY SPROUTS.

It is not always possible to secure a new growth through sprouts from the stumps of felled trees. Most conifers do not sprout effectively, and the majority of hardwoods do not sprout vigorously beyond the age of 60 years. Basswood and chestnut are exceptions, for they can be depended on to sprout well from healthy stumps up to an age of 100 years. Individual vigorous trees of other species may also often do likewise. Sprout regeneration, then, is especially

applicable to hardwood stands which are to be cut when young, as, for instance, stands which are to be cut over every 20 to 30 years for posts or fuel. It should be remembered that sprouting is most vigorous from low stumps. It is also better from the stumps of trees cut during the winter or very early spring. Such sprouts, moreover, are less liable to severe winter injury at the end of their first season's growth than are those arising after timber is felled during the summer.

In felling the trees, care should be taken to injure the stumps no more than can be helped, because the best sprouts will ordinarily arise from good, clean stumps. Because of the clean cut which it makes, the axe is a better tool than the saw in felling trees where regeneration by sprouts is desired. Regardless of what tool is used, the surface of the stumps should be slanting, so that water will not collect and promote rot.

PLANTING OR ARTIFICIAL SOWING.

Some woods are so run down that very little seed is produced and natural reproduction can not be secured even if the area is disked or harrowed, or at least can not be secured rapidly enough to be satisfactory. Often it is desirable to grow different species than those present or to grow a greater proportion of one species than another. Sometimes no woods exist at all, but one is desired. In these cases artificial sowing or planting is necessary.

Where it is desired to establish a wood lot by sowing or planting, the areas to be selected for the purpose merits some attention. A large percentage of the farmers in the unwooded plains region have planted woods around their buildings and feed lots, primarily for protective purposes. Although the trees were usually planted on very good agricultural soils, these men considered that tree production was justified even though the wood produced was not equal in value to the agricultural crops which could be grown on the same land. The monetary value of the protection to live stock and the saving which it has meant in winter fuel is difficult to estimate. Determinations have been made, however, in regard to the effect of trees as windbreaks upon the wind velocity and upon crops protected by them from the prevailing summer winds. It has been found in the prairie region that through the protection afforded by the most efficient grove windbreaks, the yield in farm crops is increased to the extent of the crop that could be grown on a strip three times as wide as the height of the trees.⁴

Where protection is not considered essential, the logical places for establishing a woods are on those portions of the farm which

⁴ Forest Service Bulletin 86, "Windbreaks," 1911.



FIG. 6.—Knolls on which timber may possibly be the most profitable crop.

are so steep or which have a soil so rocky, sandy, or wet that the returns from agricultural crops are very meager. (See figs. 5 and 6.) Steep hillsides in particular are liable to erosion; and even though good returns can be secured for a few years from growing agricultural crops on them, they are likely eventually to become so eroded as to be practically useless for such purposes. Such lands can in the long run be more profitably devoted to the growing of timber. Low lands which are not satisfactory for the growing of farm crops will produce excellent stands of some species of timber within their natural range, such as cottonwood, red gum, elm, swamp white oak, and others of a moisture-loving kind.

Species.—The species of trees to be given preference in planting or sowing operations should be those which are native to the region and which are of the most rapid growth. (See Table 2.) Though some of the most rapid-growing trees shown in Table 2 are not at present so valuable commercially as the most slow-growing ones, their values are increasing and their future increase will probably be proportionately greater than that of the others.

Spacings.—The proper spacing to give in planting trees depends largely on the habit of the species and the character of the site. In general, the more tolerant the trees are of shade and the more unfavorable the site, the closer should be the spacing. Very close spacing reduces the number and the size of the branches, which means that the trees will be of higher lumber value. It means, however, a greater death rate among them due to competition, and a higher initial cost of planting because of the greater number of trees required per given area.

On the unfavorable sites, close spacing is best. The same is true even on the better sites when cultivation can not be practiced for the first two or three years. The greater number of trees per acre offsets the higher mortality when first set out, and it results in better protection of the soil through the greater amount of shade furnished.

Species which are tolerant, that is, species that will grow well under shade, such as hard maple, beech, spruce, and hickory, can be spaced more thickly than those which are not tolerant, such as cottonwood, red pine, and black walnut. The best results will ordinarily be secured by sowing or planting a mixture of species, such as the cottonwood and soft maple, the black walnut and hickory or white oak, or the yellow poplar and hard maple. In these cases the cottonwood, black walnut, and yellow poplar would be spaced 8 to 12 feet apart and the soft maple, hickory or white oak, and hard maple would be planted midway between them. Such a combination induces rapid height growth of the first-named kinds of trees and causes them to shed their lower branches early in life; but because of the ability of the maple, hickory, and oak to live under the shade of the cottonwood, walnut, and poplar, the ground is kept well shaded and in good condition. It being kept in mind that where wide spacings are followed, it is desirable to fill in between with more slowly growing but tolerant trees; spacings about as indicated in Table 3 should be given when the trees are to be grown to an age of 40 years or more. It is not intended to thin the stand at an earlier age.

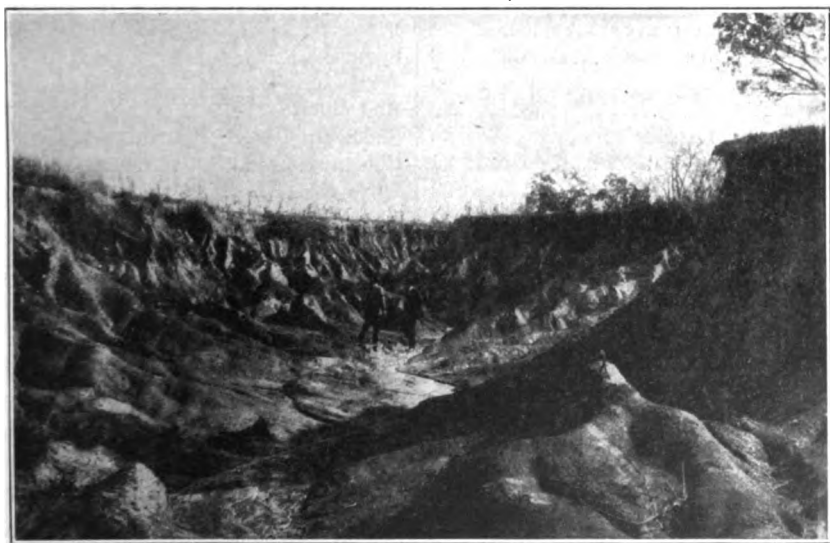


FIG. 7.—Erosion gully which could have been prevented and may now be checked by forest planting.

TABLE 3.—*Spacing to be followed in forest plantation.*

Spacing in feet.					
12 by 12	8 by 8	7 by 7	6 by 6	5 by 5	4 by 5
Number of trees required per acre.					
303	680	880	1,210	1,743	2,178
Cottonwood.	Yellow poplar. Red gum. Loblolly pine. Slash pine.	Shortleaf pine. Chestnut. Black locust. Bald cypress.	White pine. Red pine. Red oak. Black oak. Black walnut. White ash.	Hickory. White oak. Chestnut oak. Bur oak. Post oak. Red elm. Basswood.	Hard maple. Yellow birch. Beech. White spruce. Red spruce. Fir.

The species in the last two columns will withstand considerable shade without being killed, and accordingly are the ones which can most safely be used in planting midway between such trees as are shown in the first three columns.

If seed are to be sown rather than trees planted, the quantity to be used per acre depends upon a number of considerations, such as the quality of the seed, the amount of preparation given the soil, the danger of destruction of the seed by squirrels, mice, birds, etc., its price, the rate of growth of the seedlings, and their sensitiveness to frost, drought, and other such damage. If the seed is scattered broadcast on soil prepared by plowing and harrowing like grain, some such amounts as follow will be required per acre:

White and chestnut oaks.....bushels...	12	Fir.....pounds...	45
Red and black oaks.....do.....	8	Spruce.....do.....	6
Ash.....pounds.....	40	White pine.....do.....	8
Beech.....do.....	130	Red pine.....do.....	5
Maple.....do.....	40	Slash pine.....do.....	3
Elm.....do.....	24	Chestnut.....bushels.....	8
Birch.....do.....	32	Hickory.....do.....	8

If the seed are to be placed in prepared spots evenly spaced over the area, two or three such seed as walnuts, hickory nuts, or acorns should be placed in each spot and about 10 of any of the other species. This is simply to guard against failure due to the seed's not sprouting, its destruction by rodents, or the death of some of the seedlings after sprouting has occurred. The total quantity required per acre is about one-fourth to one-third that necessary in broadcast sowing.

Stock.—In general there is more certainty of success from planting trees grown in a nursery than from sowing seed directly on the

* To be sown broadcast in grass and run over with spike-tooth harrow.

permanent site. The nut-bearing trees, however—walnut, oaks, and hickories—develop during their first year a deep taproot with very few laterals. This rather unfits them for growing in a nursery and later removing them to the field. The most practicable method with these species is to sow the nuts directly in cultivated spots in the field. Fall sowing is usually preferable to spring sowing unless there is danger of the nuts being disturbed by rodents.

One-year-old hardwood seedlings and two or three year old nursery-grown coniferous seedlings or transplants are the best classes of stock for planting. They are not so large as to be unduly expensive, and ordinarily small stock is more likely to succeed than large. Transplant stock of coniferous species usually has a better root and is sturdier than seedling stock. Accordingly it is more suited for planting on inhospitable sites and on all sites where no cultivation can be given following planting.

Hardwood seedlings can very easily be grown for planting. The seed can be collected locally or bought. It should be sown in prepared beds in much the same manner as a vegetable crop, and the young trees will require no more attention than such a crop. Coniferous seedlings or transplants require more attention for their successful production, and it will usually be best to purchase such stock from a reputable nurseryman or from the State nursery, if one is maintained. At present the following States maintain their own nurseries and distribute trees either free or practically at cost to planters within the State: Maine, New Hampshire, Vermont, Massachusetts, New York, Pennsylvania, Maryland, Virginia, Ohio, Michigan, North Dakota, Kansas, Wisconsin, and Kentucky.

If purchased from nurserymen, the cost of hardwood stock will range from \$2 to \$10 per thousand trees, and that of conifers from \$3 to \$12. A list of the nurseries which handle stock suitable for forest planting can be secured from the Forest Service, Washington, D. C., for all the more important species.

TABLE 4.—Average growth of various species in different regions.

Species.	Region.	Age.									
		20 years.		30 years.		40 years.		50 years.		60 years.	
		Diameter at height of 4½ feet.	Height.	Diameter at height of 4½ feet.	Height.	Diameter at height of 4½ feet.	Height.	Diameter at height of 4½ feet.	Height.	Diameter at height of 4½ feet.	Height.
		Inches.	Feet.	Inches.	Feet.	Inches.	Feet.	Inches.	Feet.	Inches.	Feet.
Aspen.....	white	2.4-5.3	17-40	3.6-8	28-55	4.7-10.4	39-66	5.8-12.7	50-75	7.0-14.8	57-81
Northern cedar.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Ash, white.....	Minnesota.	7	4.7-8	1.2	5.7-11	1.6	13	2.1	15	2.8	18
Do.....	New York (good soil).	4.5-8.2	34-52	7.1-12.2	47-67	9.4-15.3	57-75	11.2-17.7	65-79	13.1-19.6	71-81
Ash, green.....	Ind. (fair to poor upland).	1.6-2.5	17-34	2.5-4.1	26-45	3.5-5.9	34-54	4.6-8.2	41-62	6.3-10.8	47-68
Do.....	S. Carolina (bottom land).	4.9-9.4	41-57	7.1-12.8	52-69	9.1-15.7	62-79	11.0-18.5	70-87	12.9-21.1	78-95
Basswood.....	Arkansas (bottom land).	2.2-3.3	31-(?)	7.4-11.4	45-(?)	9.7-14.6	57-(?)	11.7-17.4	67-(?)	13.5-19.9	76-(?)
Do.....	Michigan and Wisconsin.	7-13	23-32	3.6-5.1	34-44	5.0-6.9	43-64	6.5-8.8	52-63	7.9-10.4	59-70
Beech.....	Michigan.....	1.7-1.3	13-19	1.5-2.3	21-28	2.3-3.3	28-35	3.0-4.4	33-42	3.8-5.4	39-48
Do.....	New York.....	1.0-(?)	10-16	1.5-(?)	14-23	2.0-(?)	28-30	2.5-3.5	22-36	3.1-(?)	26-41
Birch, yellow.....	Michigan and Wisconsin.	1.1-2.1	20-30	1.7-3.3	26-39	2.3-4.6	31-48	3.0-5.8	37-54	3.8-7.1	43-60
Do.....	New York.....	1.8-(?)	14-22	2.6-(?)	19-31	3.5-(?)	24-40	4.5-(?)	29-47	5.4-(?)	33-53
Cedar, red.....	Alabama (open stand).	3.9	19.6	6.9	27.1	9.3	44	11.2	49	12.8	55.6
Do.....	Alabama (forest grown).	1.3	13.0	2.7	23.2	4.4	33.4	6.5	42	8.9	41.8
Do.....	New York (forest grown).	1.9	17	2.8	33	3.6	44	4.2	48	4.8	50
Chestnut.....	Maryland (sprouts).	6.8	42	9.3	57	11.4	69	13.4	77	15.1	83
Do.....	Maryland (from seed).	3.4	17	6.0	33	8.7	52	11.2	64	13.4	73
Do.....	East Tenn. (from seed).	3.1	38-55	.....	46-71	.....	52-84	.....	57-92	.....	61-98
Do.....	East Tenn. (oove type).	2.5	.....	5.6	.....	8.2	.....	11.1	.....	13.7	.....
Do.....	East Tenn. (slope type).	2.4	.....	4.8	.....	7.2	.....	11.4	.....	14.5	.....
Do.....	Connecticut.....	2.4	.....	6.4	.....	8.5	.....	12.6	.....	15.6	.....
Do.....	New York.....	4.9	.....	7.2	.....	8.4	.....	10.4	.....	21.7	.....
Do.....	West Va. (slope type).	.....	.....	4.3	.....	6.4	.....	11.4	.....	14.4	.....
Cottonwood.....	Mississippi Valley.	12.3	97	17.4	115	22.0	127	28.1	136	33.2	.....
Do.....	South Carolina.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Bald cypress.....	Louisiana.	5.2-8.1	31-45	8.1-12.2	43-61	10.8-15.9	54-75	13.3-19.2	65-96	15.8-22.2	72-97
Do.....	Maryland.....	3.5-10.0	22-44	6.2-14.2	33-58	8.7-17.6	46-71	11.3-19.5	60-82	13.3-23.2	74-97
Elm, white.....	Michigan and Wisconsin.	2.9-2.8	21	1.7-3.3	21	2.5-6.7	24	4-8.2	40	4-8.2	43
Do.....	New York.....	3.6-5.9	24-39	5.2-8.4	31-50	6.8-10.6	37-57	7.9-12.5	41-62	9.2-14.2	45-66
Fir, balsam.....	do.....	1.0-1.3	14-22	1.8-2.6	24-45	2.8-4.0	32-54	3.5-5.4	32-54	4.9-6.5	38-61
Do.....	Maine.....	1.2	14-22	1.2	25-42	2.4	30-55	5.5	45-63	6.7	52-69
Gum, red.....	South Carolina ¹ .	7.9	.....	11.2	.....	14.2	.....	16.8	.....	19.2	.....
Do.....	Missouri.....	3.8	.....	6.3	.....	9.2	.....	12.2	.....	15.1	.....
Hemlock.....	Michigan.....	7-2.0	8-18	1.3-3.9	12-21	2.1-6.7	10-42	2.9-7.6	20-53	3.8-9.4	25-92
Do.....	Southern Appalachians.	2-4.0	(?) 29	9-6.7	9-41	1.3-9.0	11-53	1.9-11.2	14-63	2.4-13.1	17-71
Do.....	New York.....	4-1.6	7-17	9-2.9	10-28	1.4-4.4	13-39	1.9-5.9	16-49	2.5-7.4	20-58

Species.	Region.	Age.											
		20 years.		30 years.		40 years.		50 years.		60 years.		80 years.	
		Diameter at height of 4½ feet.	Height.	Diameter at height of 4½ feet.	Height.	Diameter at height of 4½ feet.	Height.	Diameter at height of 4½ feet.	Height.	Diameter at height of 4½ feet.	Height.	Diameter at height of 4½ feet.	Height.
Oak, white.	Tennessee (slope).	Inches.	Feet.	Inches.	Feet.	Inches.	Feet.	Inches.	Feet.	Inches.	Feet.	Inches.	Feet.
Do.	Tennessee (cove).	0.7	.....	1.7	.....	2.6	.....	3.4	.....	4.3	.....	6.3	.....
Do.	Tenn. (second growth).	.9	.....	2.0	.....	3.0	.....	4.1	.....	5.1	.....	7.1	.....
Do.	Cove and slope.	3.3	25	5.9	38	8.3	51	10.3	63	11.7	71	13.3	77
Do.	Southern Appalachians (sprouts).	3.4	22	5.7	32	8.0	43	10.0	53	11.5	63	13.4	75
Pine, jack.	Slope.	3.9	33.2	4.4	40.8	Ridge.	.....	.....	.....	.....	.....	.....	.....
Do.	Minnesota (poor, sandy soil).	4.2	31.8	5.1	37.8	6.0-7.4	.....	7.0-8.7	.....	7.8-9.9	.....	9.3-11.8	.....
Do.	Minnesota (good, sandy loam).	4.4-5.5	.....	6.2-7.9	.....	7.5-9.4	.....	8.5-10.8	.....	.....	.....	.....	.....
Pine, loblolly.	South Carolina (old field).	6.1	38	10.0	59	13.3	75	15.9	86	18.1	94	21.5	104
Do.	South Carolina (thicket).	4.0	.....	7.4	.....	10.5	.....	13.0	.....	14.9	.....	17.7	.....
Do.	Arkansas (thicket).	3.1	.....	5.0	.....	6.9	.....	8.8	.....	10.7	.....	14.1	.....
Do.	Eastern Texas.	6.7	.....	8.8	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pine, longleaf.	Pure stand on wet prairie.	7.6	.....	12.8	.....	16.9	.....	20.0	.....	22.3	.....	.....	.....
Do.	Pure stand on light, fairly well-drained soil.	2.2	.....	3.8	.....	5.6	.....	7.8	.....	9.8	.....	13.9	.....
Do.	Mixed with hardwoods, poorly drained soil.	6.1	.....	9.5	.....	12.4	.....	15.0	.....	17.2	.....	.....	.....
Do.	Mixed with hardwoods, well-drained, fertile soil.	5.0-6.8	33-55	6.4-9.1	46-66	7.7-11.0	54-78	8.8-12.7	60-87	7.9	49	11.2	64
Do.	Maryland.	1.4	10	2.8	22	4.5	33	6.2	38	8.5-8.6	.....	11.3-12.4	.....
Do.	South Carolina.	1.2-2.2	.....	3.0-3.9	.....	4.9-5.5	.....	6.7-7.1	.....	8.2	71	10.6	88
Do.	Texas.	1.7	24	2.3	33	3.0	50	6.0	64	8.0-11.6	.....	11.5-13.7	.....
Do.	Texas (second growth).	1.5-2.8	.....	3.1-3.8	.....	4.9-8.4	.....	6.8-10.4	.....	8.0-11.6	.....	11.5-13.7	.....
Pine, red or Norway.	Texas (second growth).	2.9-5.4	35-56	6.7-10.3	58-78	8.0-13.8	70-96	9.9-16.6	77-91	11.7-18.8	82-94	14.6-21.9	88-98
Do.	Wisconsin (ridge).	2.7	.....	5.2	.....	7.5	.....	9.3	.....	11.0	.....	13.7	.....
Do.	Wisconsin (ravine).	3.3	.....	5.8	.....	8.2	.....	10.3	.....	12.1	.....	15.3	.....

Do.	2.5-6.8	21-40	4.9-10.1	35-68	6.6-12.6	47-78	8.2-14.6	58-94	9.6-16.4	66-88	12.0-19.2	76-92	13.9-21.3	82-94
Do.	1.7-2.4		2.4-4.2		4.8-5.7				6.9					
Pine, scrub.	4.8-6.8	33	6.5-8.6	46	7.8-10.1	55	9.0-11.4	63	10.1-12.8					
Pine, shortleaf.	5.7-7.2	45-51	8.1-9.9	54-59	10.1-12.0	60-64	11.7-13.6	64-68	12.9-15.1	66-71	15.0-17.5	71-76	16.6-19.4	74-81
Do.	1.6		3.4						8.2				12.7	
Do.	6.3-11.6	50-59	8.4-14.5	61-73	9.9-16.5	65-75	11.0-17.6	68-76	11.7-18.4	69-77	13.0-19.4	71-78		
Pine, white.	7.0-7.4	26-27	10.2-11.2	40-42	11.8-13.6	52-55	12.8-15.5	60-65						
Do.	2.3-4.0	14.5-24.5	3.9-6.4	28.5-44	35.8-58.8	43-61	7.0-10.8	54-75	8.6-12.8	64-86	11.7-16.5	76-102	14.5-19.8	87-113
Do.	2.8		5.3		7.6	7.6			10.7			13.0	14.8	
Do.	2.4		4.7		6.9	6.9			11.2			15.0	18.0	
Do.	2.2		4.4		6.4	6.4			10.7			14.5	17.7	
Do.	4.4		7.7		10.5	10.5			13.9			18.6	22.1	
Do.	1.9		5.6		8.5	8.5			14.7			19.5	22.1	
Do.	4.6-5.7	40	7.7-8.5	61	10.5-11.1	78	12.8-13.7	87	14.7-16.1	94				
Do.	3.0-4.6		5.0-5.4		6.9-7.3		8.7-8.9		16.3-17.0					
Do.	4.6		9.7		10.5		12.8		14.7					
Do.	6.5		9.7		12.6		15.2		17.3					
Do.	4.6	36	7.4	50	10.2	64	13.0	78	15.8		20.6		24.6	
Do.	7.4		10.2		12.7		15.0							
Spruce, red.	.1		.6		.8		1.1		1.5		2.2		3.2	
Do.	.3	5	.4	6	.7	8	1.0	9	1.3	11	2.0	14	2.6	18
Do.	.3	5	.7	7	1.1	8	1.5	10	2.0	12	3.2	18	4.4	27
Do.														
Do.		2		4	.4	5	1.1	7	1.8	9	3.1	16	4.2	26
Do.														
Do.	2.0	12-21	4.2	24-32	5.9	35-43	6.9	43-51	7.6	49-58	8.9	56-66		
Do.	0.3-1.2	6-11	0.9-2.7	10-20	1.5-4.3	13-30	2.1-3.8	17-39	2.7-7.2	2-47	4.1-9.8	29-60	5.3-12.3	36-72
Do.	1.5-1.7		2.5-3.4		3.3-4.9		4.2-6.0		4.7-7.0		5.9-8.5		6.9-10.0	
Do.	1.6		2.5-2.9		3.3-4.9		4.2-6.0		4.7-7.0		5.9-8.5		6.9-10.0	
Pine, slash.	7.5-9.4	42-60	9.8-12.3	62-73	11.5-13.8	68-83	12.0-13.2	75-88	5.8		6.9		7.8	
Do.	5.4-7.3	34-50	6.8-9.9	46-66	8.0-11.9	55-72	9.0-12.3	68-76	5.8		6.9		7.8	

Diameters inside bark on stumps 2 feet to 3.5 feet high.



41.9.
No. 1177

Rw

Care and Improvement of the Farm Woods



U. S. DEPARTMENT OF AGRICULTURE
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PROTECTION and proper cutting or "weeding" help the farm woods in the same way that they help field crops.

Trees grown so close together in stands that their tops are nearly in contact produce clear high-grade timber products.

Young trees should be coming up in the openings. Such trees should be encouraged by keeping out livestock and fire and by the use of proper cutting methods. Sometimes it is necessary to plant young trees.

In cutting timber inferior kinds of trees should be cut to a smaller diameter than the more valuable trees, and all defective trees should be removed in order to improve the quality of the farm woods.

Grass in the woods is a sign that the trees are not close enough together or that the woods are being mistreated. Pasturing and timber raising at the same time on the same area are mutually disadvantageous.

Timber is an important farm crop, helping to increase materially the total farm income.

Care and improvement of stands of timber pay the farmer well. When given a little help and guidance by protection and the right use of the ax and saw, nature responds quickly in stimulated growth and also in improvement in the quality and value of the product.

CARE AND IMPROVEMENT OF THE FARM WOODS

By C. R. TILLOTSON, *senior forester, Forest Service*

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INTRODUCTION

THE FARM WOODS frequently furnish an essential portion of the farm income. Providing proper conditions for the growth of the trees will pay the farmer well both in comfort and in cash. If properly cared for, the woods will furnish at all times a convenient supply of timber, fuel, fencing, and the like for home use and at intervals will yield valuable material for market. If neglected or abused, farm timber stands are sure to deteriorate and may eventually disappear altogether.

On farms which have no woods the owner will often find neglected corners or poor-soil slopes where planted trees would be a profitable investment. The most should be made of these, for there are times when wood is as urgently needed as the products of the kitchen garden. The aim of this bulletin is to point out methods of caring for and improving farm woods so as to make them contribute as much as possible to both the owner's convenience and his purse.

By far the greater number of farm timber stands are in need of improvement. Poorer species are in the majority and are crowding out the better ones, many of the trees are overmature, some show evidence of attack by insects or disease, some are dead, young trees are entirely lacking in the open places, and grazing is often allowed to the extent of damaging the older trees and preventing reproduction. Improvement of these conditions may be secured through judicious use of the ax, by assisting natural reproduction, by the general exclusion of livestock from the woods, and, where necessary, through planting small trees, acorns, or nuts.

TYPES OF WOODS

There are two general types of farm woods, each of which requires a different method of handling: (1) Those characterized by the presence of old trees which dominate the stand, and (2) those made up of a nearly even-aged stand of second-growth trees.

Where old trees dominate the stand they may almost totally exclude the younger growth, or they may exist only as a few scattered individuals throughout the stand. Such timber is very likely to be deteriorating in quality. The problem is gradually to remove it, at the same time provide for a new stand of seedlings, and keep the stand of timber growing at a good rate. From the standpoint of sound business management, mature trees should be cut just as ripe wheat or oats are cut. The cutting of such trees usually is also desirable for the good of the remaining stand. Dead or diseased timber should not be allowed to stand. The first operation necessary, then, in woods of this type is to cut out at once the dead and diseased material. The second is to cut the mature living trees as soon as sufficient reproduction is started in the openings and marketing conditions permit a satisfactory sale. Heavy stands composed almost wholly of mature trees should not be removed all at once but gradually, to provide for a recurring income over a period of years.

In woods where the stand of old trees is not dense and reproduction is already well started, the mature trees should be cut as soon as this can be done profitably. Unless removed, these mature trees will suppress and kill young trees otherwise which would eventually be very valuable.

Where the woods are made up of nearly even-aged stands of second-growth trees, undesirable species may predominate and may be crowding out the better ones, or the stand may be overcrowded or understocked and not reproducing. The improvement of such woods may be brought about by various cuttings known as improvement cuttings and also by practicing certain methods of regeneration, both discussed later.

Thus, as a rule the harvesting of timber on small tracts such as the average farmer's woodland is a gradual process. The general rule to be kept in mind is to cut selectively, lightly, and profitably, and thus keep the stand in perpetual production.

ESSENTIALS OF GOOD FARM WOODS

The timber crop, like any other, should be judged by its quantity and quality. The end sought, therefore, should be to secure a full stand of trees of high quality. Fortunately, the quality of timber is determined very largely by how close together the trees are. To be of high quality, timber must be, for a considerable part of its height, free from limbs which are the cause of knots; it must be tall; and it must not taper too much from the butt to the top of the last log. In a dense stand of timber there is much competition for sunlight among the individual trees, with the result that height growth is increased. Trees in crowded stands are usually taller than those in uncrowded stands of the same age. When the trees are crowded so that sunlight does not reach the lower branches, these branches soon die and become brittle; they then fall off or are broken off by the wind, snow, or other agencies. By this process trunks are formed which are free from limbs, and hence of high quality.

When trees are crowded, their diameters do not decrease rapidly from the butts to the tops. In uncrowded stands just the opposite is true; height growth is usually less; the lower branches continue to live, increase in size, and form large knots; and there is a much

greater taper in the trunks of the trees. It is evident, therefore, that in good stands the trees should be so crowded that the crown or top of each individual tree is nearly in contact with those of its nearest neighbors. A well-stocked stand of trees produces not only a larger number but also a greater proportion of high-quality trees than an uncrowded stand occupying an equal area. This is shown in figure 1. This fact is of vital importance because the price of logs of first quality is usually from one and one-half to two times as much as that paid for logs of poor quality. Likewise clear straight trees are necessary to make poles or piling.

DENSITY OR STOCKING

The approximate number of trees desirable per acre is given in table 1. The figures apply to oak, aspen, hickory, elm, and ash, but are from 15 to 20 percent too low for maple, basswood, yellow birch, beech, and white or red pine. For shortleaf, loblolly, and slash pines the numbers should be twice or three times those given in table 1 if the stands are to be well stocked.

TABLE 1.—*Desirable number of trees per acre*¹

Diameter 4½ feet, breast high (inches)	Number of trees ² when their diameters range from—				Number of trees ² when all are of uniform diameter
	2 to 10 inches	2 to 14 inches	6 to 18 inches	10 to 24 inches	
2.....	400	300	—	—	2,000
4.....	180	130	—	—	900
6.....	105	75	75	—	510
8.....	65	45	45	—	320
10.....	50	30	30	30	235
12.....	—	25	25	20	170
14.....	—	20	20	16	130
16.....	—	—	15	12	100
18.....	—	—	12	11	85
20.....	—	—	—	9	75
22.....	—	—	—	8	65
24.....	—	—	—	7	55
Total.....	800	625	222	113	—

¹ Data furnished by E. L. Sponsler, University of Michigan.

² Of the respective diameters indicated in the first column.

KINDS OR SPECIES OF TREES

From the standpoint of rate of growth and marketing, some species are preferable to others. Black walnut, white oak, and yellow poplar, for instance, are now of more value than black oak, sycamore, or beech. It is probably best, as a rule, to grow those species which will produce the largest amount of wood within a specified time rather than to attempt to grow the species most valuable at a particular time. This means that trees of the most rapid growth which are well adapted to the region and situation and not subject to serious insect or disease attacks should be left to build up the stand.

The comparative rates of diameter growth of the most important species for which data are available are about as shown in the tabulation on page 5.¹ For the rates of growth of individual species in different regions table 3 (p. 22) should be consulted.

¹ Based on measurements of natural forest stands except where marked with an asterisk (*), in which case the figures are based on growth in forest plantations.

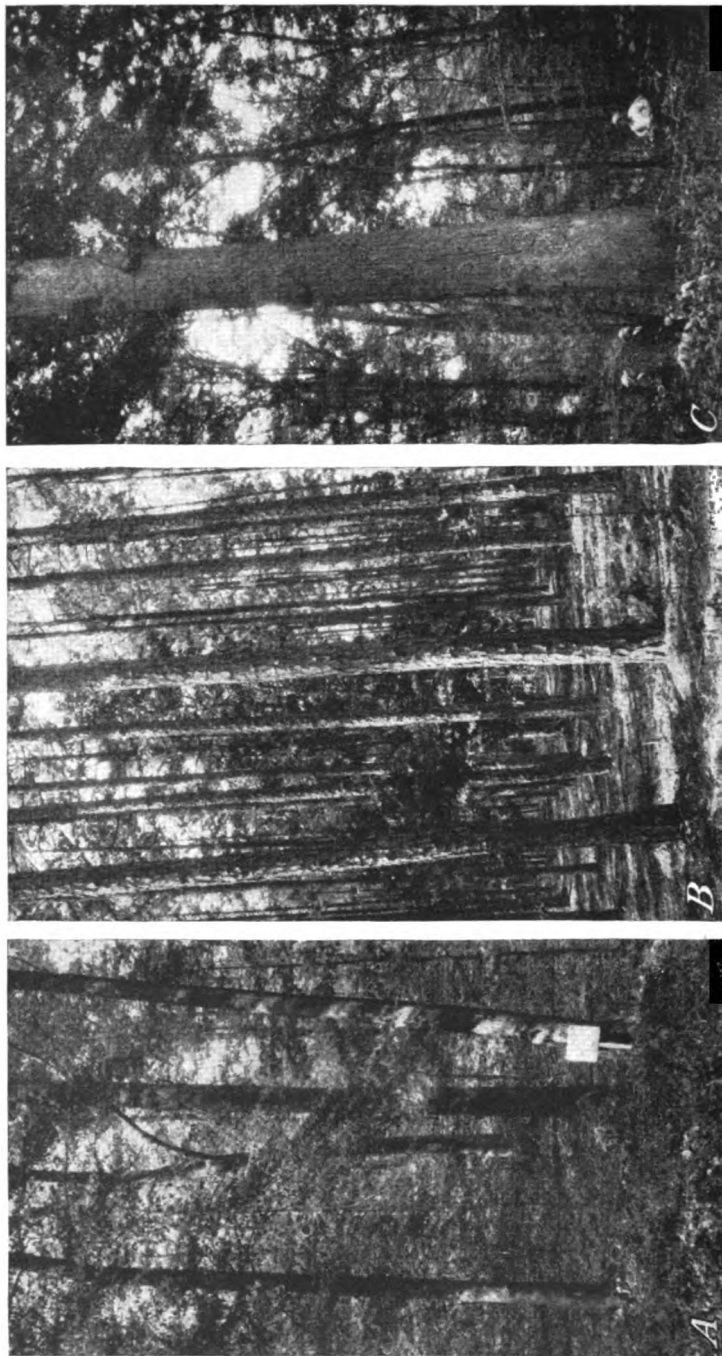


FIGURE 1.—Results of good timber management of farm woods: *A*, Valuable hardwoods; *B*, thrifty shortleaf pines evenly spaced by proper thinning; *C*, a timber-minded farmer, 64 years old, had made a good income all his life from his woods. For this white oak he had been offered as much as \$250.

Average number of years required to grow 1 inch in diameter	Species
2 to 4.....	Cottonwood,* black willow,* white willow,* honey-locust,* black locust.
3 to 5.....	Shortleaf pine, bald cypress, slash pine, loblolly pine.
3 to 6.....	Red gum,* silver maple,* white elm, yellow poplar,* hardy catalpa.
4 to 7.....	White ash,* green ash,* boxelder,* black walnut,* white pine, red pine,* butternut, red oak, southern red oak, black oak,* bur oak, aspen,* Osage-orange, basswood.
5 to 10.....	Hickory, white oak, chestnut oak, paper birch, yellow birch,* hard maple, beech.
8 to 10.....	Red spruce (second growth).
9 to 18.....	Hemlock, balsam fir.
18 to 25.....	Northern white cedar.

The slower-growing species, particularly those listed in the last four lines of the tabulation, will not reach merchantable size as soon as the others, and from an investment standpoint should not be favored in the young growth, provided some of the more rapid-growing kinds will succeed. The value of these slow-growing species for farm purposes, however, will often make it equally desirable to encourage the growth of at least a few of them if the owner wishes material particularly fitted for his own farm uses.

IMPROVEMENT CUTTINGS

Any cutting designed to remove some of the trees in a stand for the benefit of the remainder is called an improvement cutting. When made in stands of seedlings or small saplings, such cuttings are for convenience designated as cleanings; when made in somewhat older stands, they are known as thinnings; when made in stands where scattered old trees are suppressing valuable young growth, they are known as liberation cuttings.

CLEANINGS

Often in young stands some of the less valuable species, such as chokecherry, black gum, and Virginia (or scrub) pine, threaten to overtop, crowd out, or damage the more valuable species such as white ash or yellow poplar; sprouts sometimes arise too thickly from the stumps of trees recently cut; or the reproduction of good species is too dense. In any of these cases some of the trees should be removed. Cleanings are nothing more than the weeding out of the poorer species or the poorer individuals where these interfere with the better ones. The practice of lopping the tops of the inferior species rather than cutting them off near the ground may be followed. The trees will then continue to live, force the growth of the better species, and still continue to shade the ground. Both to decrease costs and to avoid overcutting, only those inferior trees which are actually interfering with the better ones should be removed. The material cut out will usually be too small to pay for the expense involved. The justification for cutting lies in the bettering of the remaining stand.

THINNINGS

Young stands ordinarily reach a condition at ages of from 15 to 20 years which makes removal of some of the trees advisable. By means of thinning, the stand of trees that is to form the mature crop can be regulated and improved. The principle is the same as that applied by truck gardeners or orchardists who thin out their crops to secure the best development of a portion rather than a poor development of the whole. By crowding at the beginning, trees of high commercial quality are produced; but if crowding is allowed to continue after the lower branches die, it will cause stagnation both in diameter and height growth.

The presence of dead or dying trees in the stand, a dense interlocking of the tops or true canopy, stems very slender in proportion to their height, or an apparent stagnation in the height growth, indicate that a thinning is needed. Unless the condition of the stand makes earlier thinnings desirable, the best practice is to defer the first one until the product is merchantable and of sufficient size and value to pay for the operation. Thinning should be repeated as often thereafter as the wood growth has accumulated in sufficient quantity to pay for the cost. Often thinnings should be made every 5 years. Light thinning every 3 to 5 years is preferable to heavier thinning at longer intervals. The tendency always is to cut too heavily.

Fuel wood, pulpwood, and posts, will ordinarily be obtained from the first thinnings and larger-sized material from the later ones. In a small woods, thinnings may be made by the owner at odd times at no cost other than his own labor. When trees are cut for any use, care in their selection will pay in avoiding damage to the future stand.

As a rule the trees having the least prospective value should be removed (fig. 2). In any young stand the trees may be assigned to several classes according to the position of their tops or crowns—dominant, codominant, intermediate, suppressed, and dead. Dominant trees are the tallest ones, those whose tops receive almost complete sunlight; codominant trees are those of slightly less height that have relatively good tops which are not, however, fully exposed to sunlight; intermediate trees, which are in the process of being crowded out, are considerably smaller than those of the first two classes; suppressed trees are those that are hopelessly behind in height growth and will either be killed soon by the shade of the other trees or continue to exist only as stunted individuals. The trees which remain after a thinning should, as a rule, be those of the best form regardless of species, the most rapid growing, and, presumably, those of the highest final market value.

The trees to be removed should, accordingly, be the dead ones and those of the least-valuable and the slowest-growing species in the suppressed and the intermediate classes; but insect- and disease-infected specimens of all classes should by all means be taken out. To obtain a proper opening of the crown canopy, some of the dominant and codominant trees may also have to be cut.

In thinning, it must be remembered that the condition of the soil very much influences the health and vigor of the forest trees. The soil should be kept fresh, soft, loose, and free of a mat of grasses. With field crops this condition is attained by cultivation. In woods it must be secured by keeping the ground shaded and free from the

trampling of livestock. In making thinnings, therefore, it is desirable to retain any of the intermediate or suppressed trees which are necessary for shading the ground.

The extent to which the overhead crown canopy of a stand may be opened depends largely on the rate of growth of the trees and their demands for light. In general, openings should not be so large that they will not close again within from 3 to 5 years through the growth of the remaining treetops. In stands of rapid-growing trees, such as cottonwood, yellow poplar, red gum, loblolly, or slash pine, the crown canopy of the dominant class of trees can be opened to a greater extent than in stands of slower-growing species, such as white oak, ash, basswood, etc. Definite rules regarding the amount of material to be



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FIGURE 2.—Trees to be cut in improving the woods should be marked with paint or whitewash. The best time for marking is when the leaves are on; the best time to cut is usually in the winter. If the crooked, diseased, and slow-growing trees are removed, the growth rate and the cash value of the remaining trees will immediately begin to increase.

removed are not possible for all conditions, but generally not more than from one-fifth to one-fourth of the wood volume should be removed at a time (fig. 3).

The returns from thinnings will depend largely upon the market for the material removed. If the material is small and suitable only for a poor class of cordwood, it is quite likely that the product will not pay for the cost of the operation. It must be remembered, however, that the increased growth and value of the remaining product will usually fully offset this cost. The material taken out in thinnings may accordingly be considered as net gain. Where the market is good, thinnings have been made at a net profit of from 25 cents to \$2 per cord. In one 8-acre woods of white pine in Connecticut thin-

nings netted the owner \$44.32 per acre. When the thinning removes material suitable for posts, handle and hub stock, small piling, or ties, the operation undoubtedly will pay for itself. Pulpwood offers an excellent market for wood cut in improving the stand. The stumpage



NC-773

NC-853

FIGURE 3.—Well-managed farm woods in which the defective and less-valuable trees have been cut for fuel wood: *A*, Mixed hardwoods, including white and red oaks, hickories, and yellow or tulip poplar; *B*, 8 cords per acre have been cut, leaving 200 to 300 trees per acre to grow high-quality timber products.

returns vary all the way from 10 cents a cord for pine in some parts of the South to several dollars for spruce in New England.

LIBERATION CUTTINGS

Scattered old trees suppressing valuable young growth will often be found in woods that have been formed from seeding by adjoining trees of such an area as a worn-out pasture. The first trees to start

often have an abundance of room and consequently form very branchy stems and wide-spreading crowns. Such trees, commonly known as "wolf" trees, will never be of much value for lumber or poles, and their wide-spreading habit often results in suppressing and killing younger and better-formed seedlings or saplings which ultimately would be of considerable value if the conditions were more favorable. It is best in such cases to remove the old trees at once. A very similar condition is also found in woods which are the remnants of virgin stands. Scattered old virgin trees remain which, through shading, are hindering the growth of younger trees. Often these older trees, because they at one time grew in a dense stand, have a high commercial value. They should be removed as soon as a satisfactory sale can be arranged.



F-219930, F-36875A

FIGURE 4.—Different kinds of improvement cuttings: A, Cut out rough, limby trees of poor form for quality timber; B, cut grapevines, except a few on low-grade trees, to be left for wildlife. This farmer let the grapevine kill this fine black walnut tree in his woods close by the home.

CUTTING OUT VINES

Grapevines, ivy, honeysuckle, and woodbine occur widely in the woods and often twine about the trunks and spread throughout the tops of the trees. They affect both conifers and hardwoods and do more damage than is commonly realized, as shown in figure 4. When they are large, their heavy foliage and small branches shade out and kill the leaves and thereby the trees. Also by their sheer weight they often bend over the tops of the trees, which are thus either killed or made unthrifty.

The vines themselves have no material value, and they should accordingly be eliminated by severing the main stem near the ground. It will be best to carry on this operation while the vines are small and

before they have done any appreciable damage; and, if lack of time prevents a thorough job, cut at least the larger ones which obviously are doing most harm. The food value to wildlife of fruit from different kinds of vines is something which should always be kept in mind. It is always well, therefore, to leave some vines on trees of little commercial value because of their importance in maintaining a full measure of beneficial or valuable population of birds, rodents, and mammals.

PASTURING FARM WOODS

Pasturing the woods has been one of the chief causes of their depletion and low earning power. The severity of the damage depends largely upon the number of stock and the size of the woods. One characteristic of a heavily pastured woods is the almost complete absence of young growth, or its existence only in small ragged patches as broken or scrubby stuff. Cattle, horses, sheep, or goats eat young seedlings, particularly the hardwoods, trample them out, or brush against them and break them off. Hogs eat the seed and thus prevent reproduction from starting, or root young seedlings out of the ground, and sometimes eat the roots (figs. 5 and 6).

In those parts of the southern longleaf pine region where hogs run at will, they are known to do a great deal of damage to longleaf pine seedlings and often damage trees several feet in height. When driven out of the swamps by high water in the late winter and early spring, they root up the longleaf pine seedlings and eat the sponge bark on the roots. Observations first carried on at Urania, La., have shown stands of several thousand longleaf pine seedlings per acre on areas protected against hogs and no seedlings on adjacent areas which were unprotected. Generally the grazing of other livestock in the southern pines is not particularly harmful and may even be beneficial in reducing the fire hazard.

Tree growth is severely damaged through trampling and wounding the roots and through compacting the soil to such an extent that it is almost impervious to water. Horses sometimes peel the bark from trees. Old trees show the abuse in the dying of their tops, in a decrease in the amount of foliage, and often in the beginning of decay at the butts. A light cover of grass then makes its appearance and increases the drying of the soil.

When the crown canopy of a woods in unbroken and young growth is not desired, a few cattle may be grazed. They should not, however, be turned in when the ground is very soft—when the frost is going out, for instance, or during a rainy season. The soil is too easily compacted at that time. When it is desired to secure natural reproduction, hogs may be turned into the woods shortly before the seed is to fall. They will root up the ground and put it in good condition for the reception of the seed. Thereafter, however, they should be kept out.

Goats and sheep should be allowed in the woods only when it is desired to clear up brush of undesirable species, so as to make possible the reproduction of better ones. If the better species are already present in mixture with the poorer ones, some method of cutting, rather than grazing, should be followed to clear the area of the poorer species. Horses should at no time be permitted in the woods.



F-23900

FIGURE 5.—Woods in which cattle and hogs have run. There are no young trees to fill up the openings; the soil is packed tight, sheds rainfall quickly, and is very dry when trees need moisture in summer. Such pasture is hard on the cattle, for the shaded ground affords but little grass.



F-22/104

FIGURE 6.—Woods protected from livestock are reproducing themselves by seeds and sprouts and growing rapidly because of the shade and moisture afforded by the natural, spongy ground cover of humus, litter, and young growth.

Stockmen are quite generally agreed that grass produced under the shade of timber is considerably less nutritious than the same species growing in full sunlight. It is also usually much more sparse. The actual value, then, of woodland pasture is small. Fifty cents to one dollar per acre per year is probably a liberal estimate of the value of woods forage. Thrifty, fully stocked stands of timber will grow at the rate of 250 or more board feet of lumber per acre or the equivalent in other products per year. Considering only this growth and assuming the value of the standing timber to be from \$5 to \$15 per 1,000 feet board measure, the value of the timber growth is from \$1.25 to \$3.75 per acre per year. Stumpage values are sometimes much higher than this, especially if there is considerable white oak, yellow poplar, walnut, or other valuable species in the stand. If the timber is given good care, moreover, the growth should be as much as 500 board feet



F-24286

FIGURE 7.—This farmer has good reason to be commended for his profitable practice of excluding all livestock from this woods and affording the animals plenty of shade in a sunlit pasture.

per acre per year. The greater value of the woods for growing timber, as compared with the value of its forage only, is apparent (fig. 7).

It must not be thought possible to secure this growth of timber and utilize the woods for pasture at the same time. Grass in the woods is almost an infallible indication that the woods are not fully stocked or are being mistreated. Grass will not thrive without strong sunlight, and in a woods in good condition sunlight reaches the forest floor only to a very limited extent. Pasturing and timber production cannot, therefore, be practiced on the same area except to their mutual disadvantage; and the combination of the two will not pay the owner as well as the practice of either one separately.

However, the value of shade to stock is sometimes very considerable as compared with the loss in timber growth because of pasturing. If, however, shade rather than forage is the chief value of the woods to stock, it can usually be provided by allowing the stock to range in

only a portion of the woodland. The remainder may more profitably be devoted to the production of wood alone.

FIRE PROTECTION

In the North, because farm woods exist for the most part as small, scattered bodies of timber, which are constantly under the owner's supervision, there need be very little damage from fires. In the South, where farm woodlands are often of considerable extent and where it is still the common practice of some people to burn the woods for various reasons, special precautions need to be taken to keep out fires.

It is commonly possible to plow several furrows around the woods, which will assist in stopping a fire. Perhaps a close watch during the fire season and vigorous measures to fight fire once started are the best that can be done at present. In addition, an endeavor can be made to arouse public sentiment against setting fire in the woods. Owners are increasingly concerned about fires in their woods, because they do realize that these may do great damage. Fire burns the fallen leaves and accumulated litter of several years, thus destroying the material with which trees enrich their own soil. The soil becomes exposed, evaporation is greater, and more of the rain and melted snow runs off the surface. The roots may also be exposed and burned. Conditions are such that the vitality of the trees is weakened and their rate of growth decreased. Fires often kill a great many of the young seedlings up to 1 inch in diameter. Although this young stuff is still often regarded as brush, it must be remembered that every large tree was in the brush stage once and that the brush of today will be the large timber trees of the future.

Very severe fires kill some of the larger trees and burn through the bark of others. These wounds lower the value of the butt log for lumber, and afford a ready point of entrance for rot-producing diseases, which often cause deterioration in the quality of the logs for a considerable distance above the wounds. By the entrance of rot the sale value of a tree may easily be decreased by from one-half to two-thirds. Rotten logs are seldom classed as No. 1, and usually as culls. Fires, then, may be expected to destroy the vegetable manure of the forest floor, to kill young growth, to weaken vitality and growth of older trees, and to lower the sale value of timber. Through the killing by fire of the young growth, which permits more light to reach the forest floor, the growth of grass is encouraged, and pasturing is probably made somewhat better, but it is believed that, everything considered, the burning of woods to improve the pasture does not pay.

The attitude of the landowner toward fire has much to do with what the neighbors, hunters, or other visitors do to prevent fire. It is possible to mold local public sentiment on the subject. A firebreak in the form of a strip of plowed furrows exposing fresh mineral soil around the timber or connecting roads or open fields often serves effectively in stopping ground fires, or as a break in backfiring if perchance the conditions should seem to warrant this hazardous practice. Such a firebreak is shown in figure 8. Tools for fighting fire include rakes, shovels, fire flappers, or swatters (rectangular pieces of old belting fastened to a small pole handle), and buckets. These should be kept readily available during fire seasons.

INSECTS AND DISEASES

Damage from either insects or disease is always possible. It is more likely to be serious with some species of trees than with others. Disease is likely to be worse in woods which have been damaged by fire, grazing, lumbering, wind, or any other agency which has served to break the bark or roots and expose the living inner tissues.

The damage done by a leaf-eating insect is apparent in the destruction of the foliage. When the insect is one that works under the bark and either bores into or girdles the tree, its presence is manifested by fine sawdustlike particles of wood which fall out of the burrows and collect either around the base of the tree or at the entrance of the burrows. Sap or gum also often exudes from these entrances. When the attack is serious, the leaves of hardwoods change to their autumnal color, while those of conifers become brown or red. The bark of



FIGURE 8.—A plowed strip several furrows in width forms a firebreak for slow ground fires and for backfiring if conditions warrant such hazardous action.

trees killed by girdling insects becomes loose; and on its inner surface, as well as on the surface of the wood of the tree, there will be found more or less numerous regular wavy passages, or so-called galleries. These are formed by the grubs as they eat their way under the bark. The wood is their food during the course of their development.

The presence of wood-rotting disease is indicated by hollow stems, discoloration and rot of the wood, and by fruiting bodies. These are the mushroom- or bracket-shaped bodies which appear somewhere on the trunk, branches, or roots of the tree, most often at some point where the tree has been wounded. Other types of disease which may seriously damage trees but do not rot the wood may have rather inconspicuous fruiting bodies but are manifested by an unhealthy appearance of the tree, dying of the branches, distorted twigs or branches, sunken places in the bark, and possibly other indications.

Full information regarding the damage from either of these sources and the methods of control may usually be secured either from State experiment stations or the United States Department of Agriculture, Washington, D. C.

CARE IN LOGGING

When the timber in the woods is being cut, steps can be taken toward insuring the perpetuation of the woods and at the same time improving the quality of the stand. Lumbering operations which remove only trees of high quality, such as white oak or black walnut, and leave dead, dying, insect-attacked or diseased specimens and inferior trees should not be practiced. The diseased and dying trees will be a menace to the remaining healthy ones, and the beech, black gum, ironwood, Virginia scrub pine, and other inferior species which remain will scatter their seed over the ground, and very largely make up the future stand. In cutting, therefore, or in selling the standing timber, provision should always be made for these inferior species to be taken down to a smaller diameter than the more valuable ones and for all defective trees to be removed. To make such a provision effective, the owner should mark in some manner all the trees which he desires cut or all those which he wishes to retain in his woods. To induce the lumberman to take inferior species and small and defective trees, it may be necessary to make some concessions in regard to price. The trees which remain will be the nucleus of the future crop, and valuable species should be in the majority in sufficient quantities to seed the cut-over areas.

Unless small, straight, and vigorous trees bring higher prices per unit of measure than large ones or unless they are of species which it is desirable to eliminate, they should not be cut by the woods' owner, nor should he allow lumbermen to cut them. As trees 10 inches and less in diameter cut only very small amounts of low-grade lumber, they are of little value. Ordinarily, if they are to be sawed into lumber, the lumberman figures on paying little or nothing for them. He cannot afford to do otherwise. Trees of such sizes, however, are usually growing rapidly or will do so when the other trees are removed and they receive more sunlight. As they increase in size, they will cut not only more but also higher-grade lumber; they will, accordingly, increase faster in value than in size. It is therefore apparent that they should not be cut.

In felling trees care should be taken not to throw them into the midst of a group of young trees; otherwise these may be seriously broken or bent. Further, by the exercise of a little care when the logs are being dragged out of the woods, much breakage, bending, and trampling of the young growth can be avoided. It must be kept in mind at all times that these young trees are the first stage in the growth of the mature timber. Every care should be taken to prevent their destruction, particularly those of the better species, because such young trees represent an established growth several years old. A new stand of seedlings may not only be difficult to obtain, but it will not have the advantage of these several years of growth. When standing timber is sold, the lumberman should be charged with protecting this young material as fully as possible.

When cutting for his own use, the owner should, so far as possible, observe rules similar to those outlined for lumbering operations. Dead and defective trees can often be used for fuel wood and pulp-wood, respectively; the poorer species may sometimes serve nearly as well as the better ones for a special farm need; damage to young growth can be avoided; and the operations can be carried on at such a season of the year and in such a manner as will aid effective sprout reproduction.

PERPETUATING THE STAND

A very striking condition in the greater number of farm woods is the absence of small trees. In woods that are fully stocked with even-aged trees of about the same size, small trees need not be expected, nor should their growth be encouraged. Where, however, as is more commonly the case, the woods are made up partly of mature and partly of decadent trees that should be cut and whose crowns do not fully shade the ground, young trees should be coming up in the openings. Under normal conditions, these young trees would be present, but because of pasturing and fires often they do not start. Grass and weeds appear instead; and, if pasturing and fires continue, conditions become such that, without aid, there is little possibility of securing a natural growth of young trees.

NATURAL RESTOCKING BY SEED

If the woods have not been too badly abused and there is no heavy sod of grass present, excluding stock and fires will in time normally result in the site's restocking itself by natural seeding. Good seed years, however, come only at intervals. Even in a good seed year, the seedlings may not be able to get a start because of the sod, the packed condition of the soil, or unfavorable weather. Natural reproduction may, therefore, be very slow, becoming satisfactory in amount only after from 5 to 10 years. It will often be advisable, therefore, when there is a good crop of seed on the trees, to put the ground in such shape as to insure a good crop of seedlings. Before the seed is scattered from the trees in the autumn, the ground may be disk-harrowed or cultivated, or hogs may be turned in to root up the soil. The seed will then lodge in the soft earth, where, upon sprouting, the roots may easily take hold. To prevent undesirable species from obtaining a foothold, any trees of such species large enough to bear seed should be cut at the time pasturing is discontinued.

To secure natural reproduction an old, mature, dense stand will normally have to be opened up in two, three, or more cuttings, each taking one-third to one-half or less of the trees. The first cutting is designed to open up the crown cover somewhat, so that the leaves on the forest floor may decompose more rapidly, the mineral soil become exposed, and the germination of seed be more certain. The remaining trees become more wind-firm, and, as a result of their crowns receiving more sunlight, they produce more seed. When the forest floor is in good condition, the later cuttings may be made during winters following heavy seed crops. With the removal of these trees the conditions will be favorable for the germination of the seed and the growth of the seedlings. Neither of the first two cuttings should be so heavy that enough light will reach the ground to encourage a heavy growth of weeds or grass. The later cuttings should be made

after the seedlings are well established and no longer in need of the protection of the old trees.

REGENERATION BY SPROUTS

It is not always possible to secure a new growth through sprouts from the stumps of felled trees. Most conifers do not sprout effectively, and the majority of hardwoods do not sprout vigorously beyond the age of 60 years. Basswood is an exception, for it can be depended on to sprout well from healthy stumps up to an age of 100 years. Vigorous individual trees of other species may also often do likewise. Sprout regeneration, then, is especially applicable to hardwood stands which are to be cut when young, as, for instance, stands which are to be cut over every 20 to 30 years for posts or fuel. It should be remembered that sprouting is most vigorous from low stumps. It is also better from the stumps of trees cut during the winter or very early spring. Such sprouts, moreover, are less subject to severe winter injury at the end of their first season's growth than are those arising after timber is felled during the summer.

In felling the trees, care should be taken to injure the stumps no more than can be helped, as the best sprouts will ordinarily arise from good, clean stumps. Because of the clean cut which it makes, the ax is a better tool than the saw in felling trees where regeneration by sprouts is desired. Regardless of what tool is used, the surface of the stumps should be slanting, so that water will not collect and promote rot.

PLANTING TREES OR SOWING SEED

Some woods are so run down that very little seed is produced and natural reproduction cannot be secured even if the area is disked or harrowed, or at least cannot be secured rapidly enough to be satisfactory. Often it is desirable to grow species different from those present or to grow a greater proportion of one species than of another. Sometimes no woods exist at all, but one is desired. In these cases planting or sowing is necessary. The planting of small trees is by far the more successful and economical method. Nut trees, such as oaks, hickories, and walnut, are the chief kinds started by direct seeding.

Where it is desired to establish a timber stand by planting or sowing, the area to be selected for the purpose merits some attention. A large percentage of the farmers in the unwooded Plains region have planted woods around their buildings and feed lots, primarily for protective purposes. Although the trees usually have been planted on very good agricultural soils, these men have considered tree production justified even though the wood produced might not equal in value the agricultural crops which might be grown on the same land. The monetary value of the protection to livestock and the saving which it has meant in winter fuel in the home, is difficult to estimate. Determinations have been made, however, regarding the effect of trees as windbreaks on the wind velocity and on crops protected by them from the prevailing summer winds. It has been found in the prairie region that through the protection afforded by the most efficient grove windbreaks, the yield in farm crops is increased to the extent of the crop that could be grown on a strip three times as wide as the height of the trees.

Where protection is not considered essential, the logical places for establishing a woods are on those portions of the farm which have steep slopes, or soil so rocky, sandy, or wet that the returns from agricultural crops are meager. Steep hillsides in particular are likely to erode; and even though returns can be secured for a few years after clearing from growing agricultural crops on them, they are likely soon to become so eroded as to be practically useless for crops. Such lands can be more profitably devoted to pasturage or the growing of timber, as shown in figure 9. Lowlands which are not satisfactory for the growing of farm crops will produce excellent stands of some species of timber within their natural range, such as cottonwood, cypress, red gum, swamp white oak, and other trees of a moisture-loving kind.

SPECIES

The species of trees to be given preference in planting reforestation operations should be those which are native to the region and which are of the most rapid growth. Red and white pines and Norway spruce lead in quantity planted in the Northern States, and shortleaf, loblolly, and slash pines in the South. Though some of the most rapid-growing trees shown in the tabulation (pp. 22-25) are not at present so valuable commercially as the most slow-growing ones, their values are increasing, and future increase will probably be proportionately greater than that of the others.

SPACINGS

The proper spacing to give in planting trees depends largely on the form or habit of the species and the character of the situation or site. In general, the more tolerant the trees are of shade and the more unfavorable the situation, the closer should be the spacing. Very close spacing reduces the number and the size of the branches, which means that the trees will be of higher lumber value. It means, however, a greater death rate among them because of competition, and a higher initial cost of planting because of the greater number of trees required per given area.

On the unfavorable sites, close spacing is best. The same is true even on the better sites when cultivation cannot be practiced for the first 2 or 3 years. The greater number of trees per acre offsets the higher mortality when first set out, and it results in better protection of the soil because of the greater amount of shade furnished.

Species that are tolerant, that is, species that will grow well under shade, such as sugar maple, beech, spruce, shortleaf pine, and hickory, can be spaced more thickly than those that are not tolerant, such as cottonwood, red, loblolly and slash pines, and black walnut. The best results will ordinarily be secured by planting a mixture of species, such as cottonwood and soft maple, black walnut and sugar maple, red oak or white oak, yellow poplar and sugar maple or white ash, white and red pines, or shortleaf and loblolly pines. Black locust is a good tree to mix with other hardwoods as it feeds them nitrogen but it grows fast and should be planted 1 to 3 years afterward. In these cases the cottonwood and yellow poplar would be spaced 8 to 12 feet apart and black walnut 30 or 40 feet apart, and the maples, oaks, white ash, or black locust would be planted between them. Such a combination induces rapid height growth of the first-named kinds of trees and causes them to shed their lower branches early in

life; and because of the ability of the other species of trees to live under the shade of the cottonwood, black walnut, and poplar, the ground is kept well-shaded and in good condition. It being kept in mind that



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FIGURE 9.—The soil on this farm-land slope is deep and rich and devoted to field crops. However, serious gullying is going on in places. The most practical treatment is to check the erosion and restore the land to timber production: *A*, The banks sloped and ready for planting small tree seedlings; *B*, a year later, the gully slopes are fixed by a mass of vegetation including black locust and black walnut trees, lespeדה, and native herbaceous growth.

where wide spacings are followed it is desirable to fill in between with more slowly growing but tolerant trees; spacings about as indicated in table 2 should be given when the trees are to be grown to an age of 40 years or more. It is not intended to thin the stand at an earlier age.

TABLE 2.—*Spacing to be followed in forest plantation*

Trees required per acre when spaced—				
12 by 12 feet Number 303	8 by 8 feet Number 680	6 by 6 feet Number 1,210	5 by 5 feet Number 1,743	4 by 5 feet Number 2,178
Cottonwood (black walnut, 30 or 40 feet apart).	Yellow poplar, red gum, slash pine, white ash.	White pine, red pine, loblolly pine, short- leaf pine, red oak, black oak, black locust, southern cypress.	Hickory, white oak, chestnut oak, bur oak, post oak, red elm, basswood.	Sugar maple, yel- low birch, beech, white spruce, red spruce, fir.

The species in the last two columns of table 2 will withstand considerable shade without being killed, and accordingly are the ones that may most safely be used in planting midway between such trees as are shown in the first three columns.

If seed is to be sown or planted rather than trees planted, the quantity to be used per acre depends upon a number of considerations, such as the quality of the seed, the amount of preparation given the soil, the danger of destruction of the seed by squirrels, mice, birds, etc., its price, the rate of growth of the seedlings, and their sensitiveness to frost, drought, and other such damage. The uncertainty of successful results from broadcasting seed, even when the soil is prepared, makes it advisable to confine direct-seeding efforts to prepared and protected spots.

When the seeds are placed in prepared spots evenly spaced over the area, two such seeds as walnuts, hickory nuts, or acorns should be placed in each spot and about 10 of any of the other species. This is simply to guard against failure of the seed to sprout, its destruction by rodents, or the death of some of the seedlings after sprouting.

STOCK

In general there is far more certainty of success from planting trees grown in a nursery than from sowing seed directly on the permanent site. The nut-bearing trees, however—walnuts, oaks, and hickories—develop during their first year a deep taproot with very few laterals. This rather unfits them for growing in a nursery and later removing them to the field. The most practicable method with these species is to sow the nuts directly in cultivated spots in the field. Fall sowing is usually preferable to spring sowing unless there is danger of the nuts being disturbed by rats, squirrels, or hogs.

One-year-old hardwood seedlings and 1- or 2-year-old nursery-grown coniferous seedlings or transplants are the best classes of stock for planting. They are not so large as to be unduly expensive, and ordinarily small stock is more likely to succeed than large. Transplanted stock of coniferous species usually has a better root and is sturdier than seedling stock. Accordingly it is more suited for planting on inhospitable sites and on all sites where no cultivation may be given following planting. All of the southern pines are planted when 1 year old.

Hardwood seedlings may very easily be grown for planting. The seed may be collected locally or bought. They should be sown in prepared beds in much the same manner as a vegetable crop, and the young trees will require no more attention than such a crop. Coniferous seedlings or transplants require more attention for successful production, and it will usually be best to purchase such stock from a reputable nurseryman or from the State nursery. Most State forestry departments maintain nurseries that grow quantities of small pines

and spruces and some hardwoods to be sold at nominal prices for planting within the State. If purchased from a nurseryman, hardwood stock will cost from \$2 to \$10 per thousand trees and conifers from \$2 to \$12. A list of State and other nurseries which handle small trees or seed suitable for forest planting may be secured from the Forest Service, Washington, D. C.

GROWTH RATES OF DIFFERENT SPECIES OF TREES

The rate of growth of different trees varies widely. Some species are inherently more rapid growers than others; for example, the red oak, silver maple, white pine, and slash pine grow faster than the white oak group, sugar maple, red pine, and longleaf pine. Many kinds, including the ashes, American elm, and black walnut, are intermediate in rate of growth (fig. 10).



F-248029

FIGURE 10.—Thousands of farmers could easily have hundreds of black walnut trees growing in unused corners in their fields and along fence rows and streams. Black walnut trees are readily started by planting the nuts or 1-year-old seedlings. There is no easier way to increase the sale value of the farm and the yearly farm income. Early prunings would have increased the sale value of these trees.

Growth is also affected by the kind of situation or site, which is determined largely by the amount of plant food and moisture in the soil and its mechanical condition, as well as the elevation and slope of the surface. The density of the stand of trees influences the amount of sunlight and soil moisture and plant food each tree finds available.

The information in table 3 is based upon a large number of observations and measurements and should prove helpful in giving an approximate idea of the sizes of specified kinds of trees growing in different regions at ages 20, 30, 40, 50, 60, 80, and 100 years. The tabulation should not be regarded in any sense as exact or rigid, but rather as indicative of about the size and, therefore, the rate of growth of the different species under the specified conditions.

TABLE 3.—Average growth of various species in different regions

Species	Region	Growth and height at age of—											
		20 years		30 years		40 years		50 years		60 years		80 years	
		Diameter at height of 4½ feet	Height	Diameter at height of 4½ feet	Height	Diameter at height of 4½ feet	Height	Diameter at height of 4½ feet	Height	Diameter at height of 4½ feet	Height	Diameter at height of 4½ feet	Height
		Inches	Feet	Inches	Feet	Inches	Feet	Inches	Feet	Inches	Feet	Inches	Feet
Aspen	Maine	2.4-5.3	17-40	3.6-8	28-55	4.7-10.4	13	5.8-12.7	15	7.0-14.8	57-81	9.3-19.2	64-87
Northern white cedar	Minnesota	7	47-8	1.2	5.7-11	1.6	13	2.1	15	2.8	18	4.2	25
Ash, white	New York (good soil)	4.5-8.2	34-52	7.1-12.2	47-67	9.4-15.3	57-75	11.2-17.7	65-79	13.1-19.6	71-91	16.5-22.8	81-93
Do.	Indiana (fair to poor upland)	1.6-2.5	17-34	2.5-4.1	26-45	3.5-5.9	34-54	4.6-8.2	41-62	6.0-10.9	47-68	10.3-18.4	57-78
Ash, green	South Carolina (bottom land)	4.9-9.4	41-57	7.1-12.8	52-69	9.1-15.7	62-79	11.0-18.5	70-87	12.9-21.1	78-95	16.4-25.9	90-107
Do.	Arkansas (bottom land)	4.9-7.8	31-72	7.4-11.4	45-72	9.7-14.6	57-72	11.7-17.4	67-77	13.5-19.9	76-77	17.0-24.2	92-92
Basswood	Michigan and Wisconsin	2.2-3.3	22-32	3.6-5.1	34-44	5.0-6.9	42-54	6.5-8.8	52-63	7.9-10.7	59-70	10.9-14.3	71-80
Beech	Michigan	2.7-1.3	13-19	1.5-2.3	21-28	2.2-3.3	28-35	3.0-4.4	32-42	3.8-5.4	39-48	5.4-7.5	48-59
Do.	New York	1.0-2.1	10-16	1.5-2.3	14-23	2.0-3.0	18-30	2.5-4.4	22-36	3.1-5.1	26-41	4.6-7.0	33-52
Birch, yellow	Michigan and Wisconsin	1.1-2.1	20-30	1.7-3.3	26-39	2.3-3.6	31-48	3.0-5.8	37-54	3.8-7.1	43-60	5.6-9.8	53-68
Do.	New York	1.8-2.1	14-22	2.6-4.0	19-31	3.5-5.7	24-40	4.5-7.2	29-47	5.4-8.4	33-53	7.4-10.7	39-64
Cedar, red	Alabama (open stand)	3.0	19.6	6.0	37.1	9.3	33.4	11.2	28.7	12.6	18.6	13.9	18.6
Do.	Alabama (forest-grown)	1.3	13.0	2.7	23.2	4.4	33.4	6.5	43.2	8.8	58.5	13.9	83
Do.	New York (forest-grown)	1.3	42	2.8	57	3.6	69	4.2	77	4.8	83	18.0	90
Chestnut	Maryland (sprouts)	6.8	17	9.3	33	11.4	82	13.4	64	15.1	73	17.2	84
Do.	Maryland (from seed)	3.4	36-55	6.0	46-71	8.7	52-84	11.2	57-92	13.4	61-66	17.2	66-107
Do.	East Tennessee (from seed)				46-71		52-84		57-92		61-66		66-107
Do.	East Tennessee (cove type)	3.1		5.6		8.2		11.1		13.7		18.4	
Do.	East Tennessee (slope type)	2.5		4.8		7.2		9.4		11.4		14.5	
Do.	Connecticut	3.4		6.4		9.5		12.6		15.6		21.7	
Do.	West Virginia (slope type)	2.4		4.3		6.4		8.4		10.4		14.4	
Do.	New York	4.9		7.2		9.4		11.4		12.9		18.4	
Cottonwood	Mississippi Valley	12.3	97	17.4	115	22.0	127	26.5	136	28.2		33.5	
Do.	South Carolina	12.6		17.4		21.4		26.1		28.2		33.5	
Baldcypress	Louisiana	5.2-8.1	31-45	8.1-12.2	43-61	10.8-15.9	54-75	13.3-19.2	63-86	15.8-22.2	74-97	21.3-28.6	92-97
Do.	Maryland	3.5-10.0	22-44	6.2-14.2	33-58	8.7-17.6	46-71	11.1-20.5	60-82	13.3-23.2	72-91	17.3-28.6	88-106
Elm, white	Michigan and Wisconsin	2.9-2.8	24-39	1.7-4.3	31-38	2.5-5.7	34	3.3-7.0	40	4.1-8.2	45-45	5.7-10.4	53
Do.	New York	3.6-5.9	24-39	5.2-8.4	37-57	6.6-10.6	37-57	8.1-12.3	41-52	9.4-16.6	43-60	12.3-20.6	49-68
Do.	do.	1.0-1.3	14-22	1.8-2.7	19-31	2.8-4.1	30-45	3.8-5.5	45-63	4.9-6.7	36-46	6.5-8.9	64-78
Fr. balsam	Maine	1.0-1.3	14-22	1.8-2.7	20-43	2.8-4.1	30-45	3.8-5.5	45-63	4.9-6.7	36-46	6.5-8.9	64-78

TABLE 3.—Average growth of various species in different regions—Continued

Species	Region	Growth and height at age of—									
		20 years		30 years		40 years		50 years		60 years	
		Diameter at height of 4½ feet	Height	Diameter at height of 4½ feet	Height	Diameter at height of 4½ feet	Height	Diameter at height of 4½ feet	Height	Diameter at height of 4½ feet	Height
Oak, white	New York (seedling)	Inches 2.2	Feet	Inches 4.1	Feet	Inches 5.7	Feet	Inches 7.1	Feet	Inches 8.2	Feet
Do.	New York (sprouts)	3.9		5.4		6.6		7.6		8.4	
Do.	Kentucky (upland and bottom)	3.6		5.6		7.3		8.7		9.8	
Do.	Kentucky (slope)	1.1		2.2		3.2		4.2		5.3	
Do.	Tennessee (slope)	1.7		3.4		2.6		4.3		6.3	
Do.	Tennessee (cove)	.9		2.0		3.0		4.1		5.1	
Do.	Tenn. (second growth):										
Do.	Cove and slope.	3.3	25	5.9	38	8.3	51	10.3	63	11.7	71
Do.	Ridge	3.4	22	5.7	32	8.0	43	10.0	53	11.5	63
Do.	Southern Appalachians (sprouts):										
Do.	Ridge	3.9	33.2	4.4	40.8						
Do.	Slope	4.2	31.8	5.1	37.8						
Pine, jack	Minnesota (poor, sandy soil).	3.3-3.9		4.8-5.9		6.0-7.4		7.0-8.7		7.8-9.9	
Do.	Minnesota (good, sandy loam).	4.4-5.5		6.2-7.9		7.5-9.4		8.5-10.8			
Pine, loblolly	South Carolina (old field).	6.1	38	10.0	59	13.3	75	15.9	86	18.1	94
Do.	South Carolina (thicket).	4.0		7.4		10.5		13.0		14.9	
Do.	Arkansas (thicket).	3.1		5.0		6.9		8.8		10.7	
Do.	Eastern Texas:										
Do.	Pure stand on wet prairie.	6.7		8.8							
Do.	Pure stand on light, fairly well-drained soil.	7.6		12.8		16.9		20.0		22.3	
Do.	Mixed with hardwoods, poorly drained soil.	2.2		3.8		5.6		7.8		9.8	
Do.	Mixed with hardwoods, well-drained, fertile soil.	6.1		9.5		12.4		15.0		17.2	
Do.	Maryland.	5.0-6.8	33-55	6.4-9.1	46-69	7.7-11.0	54-78	8.9-12.7	60-87	7.9	49
Pine, longleaf	Alabama.	1.4	10	2.8	22	4.5	33	6.2	38	11.2	64
Do.	South Carolina.	1.2-2.2		3.0-3.9		4.9-5.5		6.7-7.1		11.3-12.4	
										13.9-15.5	76

[illegible]

Diameters inside bark on stumps 2 feet to 3.5 feet high.

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TREE SURGERY

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FARMERS' BULLETIN 1178
UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C.

September, 1920

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THIS BULLETIN is intended primarily as a guide for those who desire to take care of their own trees or to superintend such work. It outlines some of the better methods of treating injuries, removing dead or diseased limbs, and repairing decayed spots in the trunk or limbs.

A badly diseased or injured tree should be removed and replaced by a healthy one unless there is some very special reason for trying to preserve the tree. This applies particularly to an old tree that has been in poor condition or in poor soil for some years. Such a tree rarely recovers completely from the shock of extensive or elaborate repair work on the trunk; in fact, it often deteriorates more rapidly thereafter. Two axioms of tree-repair work (tree surgery) that should be borne in mind constantly are (1) that prompt treatment of freshly made wounds is the surest and most economical method of preventing disease or decay in the future and (2) that all wounds made in tree-surgery work should be cleaned, sterilized, and protected from infection just as thoroughly as in the case of animal surgery and for exactly the same reasons.

Most persons can, at least with a little preliminary practice on the simpler types of work, undertake any of the work here outlined provided they are familiar with the use of a gouge and mallet, a saw, and a paint brush. A steady head and ability to climb will be necessary for work in the top of a tree.

TREE SURGERY.

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THE DANGER OF NEGLECTED WOUNDS.

INJURIES of various sorts are so common on trees that most people have become oblivious to the danger arising from neglected wounds, or at least they underrate the danger. Every broken limb and every wound that penetrates as far as the inner bark may become the point of entrance of active plant or animal parasites or rot-producing organisms unless these injuries are promptly and properly treated.

The best, safest, and most economical plan to prevent future extensive injury and decay or to prevent the early disfigurement or death of the tree is to attend to all injuries as soon as they occur. This kind of work is comparatively simple and inexpensive. If the injuries are allowed to remain untreated for some years (as they usually are), decay-producing organisms almost invariably enter through the wound and produce rotted areas in the wood, often to such an extent that a violent wind a few years later will break the tree at the decayed and weakened spot. Uninjured bark or an injured area promptly and properly treated usually prevents the entrance of decay organisms.

If an untreated wound of several years' standing has developed a considerable area of decayed wood or bark, the first question to be considered is whether the tree is of sufficient value to warrant the expense of repairing it properly. Should it be decided to repair the tree, the too common mistake of neglecting such portions as are difficult to reach must not be made. A thorough, complete, and sanitary job should be made, or else nothing whatever attempted. If a tree is badly decayed or injured, it is best and safest to remove it and set a healthy one in its place; or it may be braced to prevent breakage in

a violent storm; or it may have the decayed matter removed and the cavity treated in accordance with directions given in this bulletin. Trees from which large areas of rotted wood have been excavated and the cavities filled will rarely completely heal over the filling except under the most favorable conditions. Careful and thorough cavity work on the trunk of a tree is of much greater importance than on a limb, as the latter often may be cut off well behind the diseased area without materially impairing the general health of the tree.

Many people fail to realize the full extent to which properly located, healthy, and well-kept trees will enhance the value of real estate,

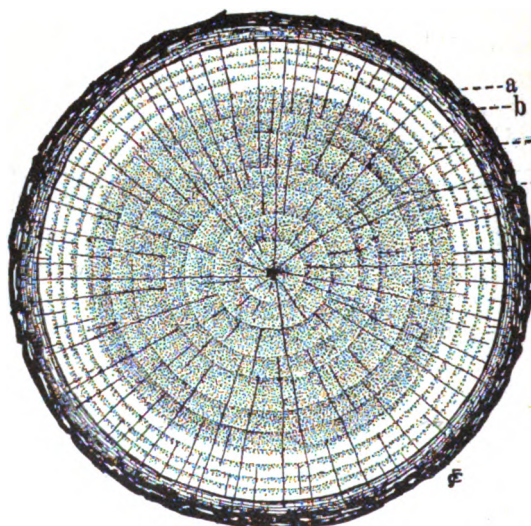


FIG. 1.—Cross section of a typical tree trunk, showing the various parts: *a*, Bark; *b*, cambium; *c*, sapwood; *d*, heartwood. The concentric rings in the sapwood and heartwood are the annual rings. The radial lines extending part way or entirely from the center to the bark are the pith rays. In this figure the outer and inner bark are represented as approximately equal in thickness.

particularly for residential use. From this point of view alone, it usually is best to keep the trees in a healthy and vigorous condition. Oftentimes, historical association, scientific value, or rarity of the species outweighs all other considerations. Trees unquestionably are a real asset from various points of view and for reasons too well known to need mention here.

When owners of trees realize more fully than at present that it costs comparatively little to

properly treat injuries at the time they are made and that such treatment means much to the health, beauty, usefulness, and value of the trees in years to come, they will have learned the greatest economic lesson connected with the care and repair of trees.¹

THE CAMBIUM.

The trunk and branches of a tree are made up of a cylinder of wood surrounded by bark. (Fig. 1.) Between the bark and the wood on healthy parts of the tree there is a very thin continuous layer of young (embryonic) tissue, which is not necessarily sharply marked

¹ For advice in selecting trees and shrubs for the home grounds, see Farmers' Bulletins 185 and 1067 and Department Bulletin 816.

off from either wood or bark. This is the cambium (fig. 1, *b*). It is this layer that splits or slips so easily in the spring time, when the bark is removed to make the familiar willow whistles of boyhood days. During the growing season its microscopic elements (cells) are constantly dividing and giving rise to new layers of cells on both sides, on the outer side of the cambium to new layers of bark, on the inner to new layers of wood. Thus, the youngest layers of both wood and bark are those adjoining the cambium. As the cambium is a very tender and thin-walled tissue, a comparatively slight injury will kill portions of it, and once killed the dead area never again can give rise to new bark or new wood. However, the healthy living cambium around the edges of the dead area will give rise each year to a new layer of more or less abnormal wood and bark unless its growth is retarded by disease or subsequent injury. Under normal conditions these new layers of wood and bark (called callus wood and callus bark) grow out each year over the margin of the dead area a little more than the width of an annual ring (see fig. 1), and eventually the dead area, if not too large, may be entirely overgrown or hidden from view. Such dead spots furnish favorable points for the entrance of insects and organisms causing decay unless they are properly treated.

All new layers of the normal wood and bark of roots, trunk, and branches originate in the living cambium, never elsewhere; consequently, it is of the utmost importance to keep the cambium in a healthy and uninjured condition at all times. Diseases or injuries that kill the cambium or large portions of it usually are fatal to the tree.

REPAIR WORK.

In repair work (tree surgery) a few fundamental principles must be observed in order to secure permanently good results. These may be summarized briefly as follows:

- (1) Remove all dead, decayed, diseased, or injured wood or bark. When on a limb this can often be done best by removing the limb entire; on a large limb or on the trunk it may mean at times digging out the decayed matter so that a cavity is formed.
- (2) Sterilize all cut surfaces.
- (3) Waterproof all cut surfaces.
- (4) Leave the work in the most favorable condition for rapid healing; this will often mean filling or covering deep cavities.
- (5) Watch the work from year to year for defects, and if any appear attend to them immediately.

SOME THINGS TO BE AVOIDED.

The careless use of a long pruning hook or other implement to break off small dead twigs should be avoided, as every bruise may become the point of entrance of disease or decay. Climbing spurs produce wounds that are very easily and frequently infected. Spurs

should never be used except on a tree that is to be removed or destroyed. A man who insists on using climbing spurs in tree-surgery work should never be allowed to work on trees. Nails and leather soles and heels on shoes often cause injury. Rubber-soled tennis shoes, or "sneaks," or some similar soft-soled shoe that will not slip should be used in tree-surgery work.

SURGERY WORK.

The simplest type of tree-surgery work consists in removing dead or dying limbs or neglected or decayed stubs and in treating the

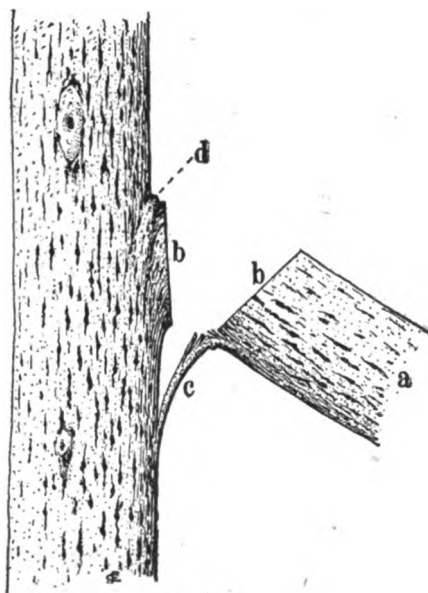


FIG. 2.—The wrong way to remove a heavy limb.

A single cut from the upper side usually makes a long wound below the scar where the bark and outer wood are stripped: *a*, Limb; *b*, saw cut that severed the limb; *c*, strip of bark and wood stripped from the trunk; *d*, shoulder of the limb.

wounds with antiseptic and waterproof coverings to prevent the entrance of decay-producing organisms and moisture while healing. A more complicated type consists in digging out the decayed and diseased wood of decayed spots and treating the freshly cut surfaces of the cavities with antiseptic and waterproof coatings and also in filling the cavities with suitable material. Artificially filled cavities do not increase the strength of the trunk or limb to the extent that is commonly supposed. An improperly filled cavity is always a greater menace to a tree than an unfilled one.

REMOVING BRANCHES.

The work of removing branches primarily includes the removal of healthy, dead, or diseased

branches when the decay or disease does not extend back on the branch as far as the point where it is to be cut off; that is, the cut is made entirely through healthy wood.² This type of work can be regarded as comprising two essential operations: (1) Removing the branches in a manner that will prevent injury to the surrounding bark and cambium and (2) shellacking, sterilizing, and waterproofing the scars.

The most essential implements for removing large branches are a good-sized saw with teeth so set as to make a wide cut, a gouge, a chisel, a mallet, a strong sharp knife, and an oilstone. For cutting

² If decay runs back into the trunk, it will be necessary to excavate all decayed matter, following the directions given later under "Cavity work."

limbs near the ground, these are the only necessary implements, though others often may be convenient. For limbs situated elsewhere, one or more ladders may be needed; also, at times, a rope.

A large limb rarely should be removed by a single saw cut from the upper side, as this usually strips the bark and wood below the scar as it falls (fig. 2) unless handled as described later. A preliminary cut should be made on the under side, usually from 6 inches to a foot beyond the point where the final cut is to be made. It should reach from a quarter to half way through the limb (fig. 3, *a*). A good time to stop cutting is when the saw becomes pinched in the cut. A second cut should be made on the upper side of the limb, an inch or more beyond the first one (fig. 3, *b*) and continued until

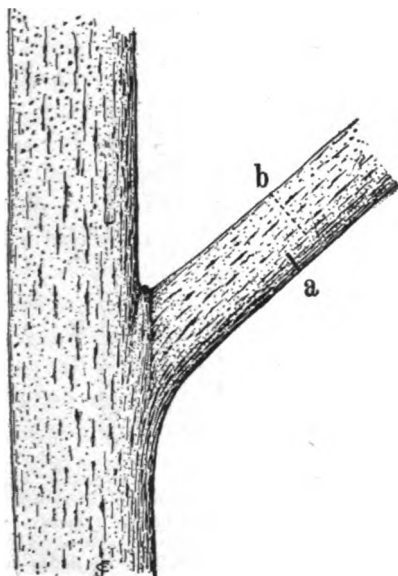


FIG. 3.—The right way to remove a heavy limb. The first cut is made on the under side of the limb, at *a*. The second cut is made at *b*, this cut being continued until the limb falls.

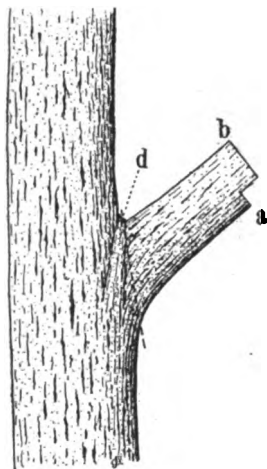


FIG. 4.—The right way to remove a heavy limb. The third cut is made close to the trunk so as to leave no projecting stub. Both *a* and *b* are the same as in figure 3; *c* indicates the position of the third cut; the shoulder of the limb is shown at *d*.

the limb falls. A third cut, to remove the stub, should then be made close to the trunk (fig. 4, *c*). When nearly severed the stub must be supported so as to avoid any possibility of stripping the bark on the trunk as it falls. The first and second cuts may be omitted when a limb is so small that it can be held firmly in place until completely severed. If desired, the edges of the scar may be smoothed with a sharp chisel to conform to the trunk.

A large limb often can be removed safely with a single downward saw cut close to the trunk if handled as shown in figure 5. It is bad practice, as well as a menace to the tree, to leave a projecting stub (fig. 6). The scar should be pointed at both ends (fig. 7), as this is the most favorable shape for satisfactory healing.

A coat of good shellac should be applied with a suitable brush over the entire cut edge of the bark, the adjoining outer sapwood, and the cambium immediately after the cut is made, or at least as soon as the cut surfaces are sufficiently dry. This is to prevent any appreciable drying out and consequent dying back of the cambium. If the cut has not been made through perfectly healthy wood, the wound should be cut back until sound healthy wood is reached. Usually it is unnecessary to shellac more than a quarter of an inch on either side of the cambium. If the scar is a large one, a sharp knife or drawshave should be used along the margin for one or two minutes, and then the freshly cut surfaces shellacked, repeating the

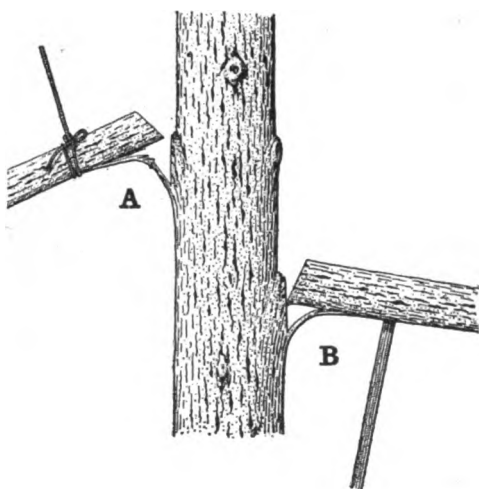


FIG. 5.—A heavy limb can often be removed safely with a single downward saw cut by supporting the limb with a tightly drawn rope, as shown at A, or by a firmly placed heavy prop, as shown at B. Both rope and prop should, if possible, be so slanted as to cause the limb to swing away from the trunk as it is severed. If the rope is tied to a living overhead branch, the latter should be well padded to prevent injury.

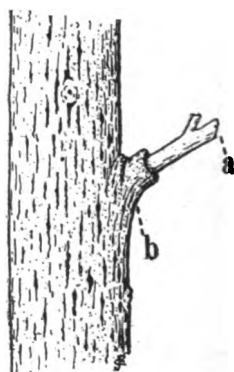


FIG. 6.—A projecting stub of decaying wood which has become a menace to the living parts adjoining. This limb was cut at the point marked a; it should have been cut at b.

operation until all the bark and outer sapwood encircling the scar have been shellacked. The maximum benefit from shellacking is not likely to be realized if the freshly cut surface is allowed to remain dry and without shellac for more than 3 or 4 minutes.³

STERILIZING AND WATERPROOFING THE WOUNDS.

Many sterilizing preparations have been used with more or less success. Ordinary commercial creosote (a coal-tar product, some-

³ The shellac brush can be cleaned readily at any time by working it around for a few minutes in a can of water in which a little borax has been dissolved. It is then rinsed in clear water and dried. The shellac can be conserved while in use by having the handle of the brush fitted tightly through a hole in the cover of a friction-top can, the cover not being removed from the brush when the latter is used to spread the shellac.

times called creosote oil), apparently is one of the best preparations for destroying and preventing the growth of certain wood-destroying fungi. It can be applied with an ordinary paintbrush and should cover every part of the exposed wood which has not already been covered by the shellac. The entire shellacked and creosoted surface should finally be waterproofed with thick coal tar or asphalt.⁴ A single application of a mixture of creosote and coal tar (about one-fourth or one-third creosote) to cover the entire scar has been quite extensively used with good results. A better mixture is made by melting asphaltum and mixing with it an equal quantity (by weight) of creosote.⁵ If too thick to apply when cold, add more creosote and stir. Asphalt, without creosote, is an excellent waterproof covering and doubtless would be more generally used were it not necessary to apply it hot. Paint frequently is used for waterproofing but is less permanent.

Creosote and tar at times will cause slight injury when used around wounds on certain trees, especially cherries, peaches, and plums. Except on magnolias and tulips such injury has not been especially noticeable on most of our common shade trees. If injury from the use of creosote and tar is feared or suspected a moderately blue solution of copper sulphate in water⁶ or 1 part of corrosive sublimate in 1,000 parts of water⁷ may be used as an antiseptic wash. As soon as this is dry the wound can be painted with any good lead paint.

Grafting wax (particularly thick liquid alcoholic grafting wax) is excellent for waterproofing small surfaces.

Another good method of treating the scars is to char the surface with a gasoline or alcohol blast torch and then quickly cover the hot

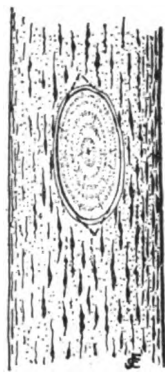


FIG. 7.—If the shoulder has been removed and the upper and lower ends of the scar are broadly rounded or square they should be pointed, as indicated by the broken lines. If the shoulder (see figs. 2, d and 4, d) has not been removed the pointing of the scar is not so important, and at times it is unnecessary.

⁴ For applying hot asphalt, use a cloth swab or a brush made of broom corn, as the bristles of an ordinary brush are usually quickly destroyed by the hot asphalt.

⁵ It usually is necessary to set the kettle or pail containing this mixture in a larger kettle of boiling water for an hour or more, in order to completely dissolve the asphalt. As creosote is inflammable, care should be taken that it does not come in contact with the flame, as might happen if the heating were done directly over an open fire.

⁶ 1 pound of copper sulphate in 3 or 4 gallons of water.

⁷ Corrosive sublimate (or bichlorid of mercury) is a deadly poison to man or animals if taken internally and is a caustic or corrosive agent on the skin or on metals. The 1 to 1,000 solution can be made most readily by purchasing the 7 or 7.3 grain tablets of bichlorid of mercury at a drug store, where they are sold subject to laws governing the sale of poisons. One of these tablets dissolved in a pint of water will make a solution of the proper strength. The solution should be freshly mixed for the best results. Usually it will retain sufficient strength for ordinary use for two or three months. If placed in an amber or blue bottle away from the light, it will keep at least two or three times longer. As a precautionary measure against the accidental poisoning of domestic animals, the discarded solution should be buried rather than poured into a sink drain or thrown out on the surface of the ground. Solutions should not be kept in metal containers, nor should brushes with metal coverings or wire-fastened bristles be used for applying it, as the solution promptly corrodes all metal with which it comes in contact.

surface with heavy tar, pitch, or hot asphalt. Heat is an excellent sterilizing agent, but it kills back the cambium considerably.

On particularly choice trees, where the black color of tar or asphalt is objectionable, the scar can be sterilized with the corrosive-sublimate or copper-sulphate solution and, as soon as dry, shellacked. After a week or two the shellacked surface should be painted with spar varnish. For many purposes and on many trees this treatment is particularly satisfactory. If the scar is clean and healthy and not located near any former area of decay or disease, the sterilizing washes may be omitted and the shellac applied directly to the unsterilized scar. The alcohol in the shellac is a good sterilizing agent. If it is desirable that the scar be colored to match the bark, a suitably colored coat of paint can be applied over the shellac and allowed to dry before the coat of spar varnish is applied, or the spar varnish may be omitted.

Permanently good results from waterproofing can be secured only when the treated surfaces are watched from year to year and re-coated annually or biennially, especially when any tendency of the coating to crack or peel is observed. This is an important part of the work, a part which is commonly neglected. It is best to recoat the wounds regularly every year or two, even though no cracks appear.

The healing of wounds by means of new callus growth at the sides is usually more rapid if neither paint nor other generally used waterproof covering is applied (shellac excepted). However, the rapid healing of the wound is of secondary importance to that of preventing the entrance of decay-producing organisms. To prevent decay is one of the most important and essential considerations in tree surgery. It is of vital importance in the care of long-lived trees. With short-lived trees it obviously is of less relative importance.

One of the best (though little used) methods of counteracting the danger arising from cracks in large flat scars, particularly scars that are sound and healthy, is to cover the freshly waterproofed wood of the wound with sheet metal, heavy tarred paper, or heavy cloth, firmly tacked down and waterproofed.⁸

For the work of removing small branches a saw, a sharp strong knife, a hand pruner, and a long pruning hook will be the most useful implements, in addition to some of those already mentioned. In removing small branches and twigs the cut should be made as close to the surface of the supporting branch as possible, so as to leave no projecting stub (see fig. 6). A sharp knife is the best tool for the work and should be used, when possible, in preference to the hand pruner or pruning hook. When the hand pruner is used the cutting blade should always be turned toward the tree, so that the

⁸ For a detailed account of this method, see the Weekly News Letter of the United States Department of Agriculture for February 9, 1916.

supporting bar makes its bruise on the part that is cut away. The long pruning hook should be used with caution and only when the place to be pruned can not be reached with the knife or hand pruner. For protection against possible infection, the pruning wounds must be sterilized and waterproofed in some such manner as that recommended for larger branches. For very small wounds shellac may be as handy to use as any preparation. Liquid grafting wax or shellac is particularly satisfactory for scars less than a half inch in width on choice trees or shrubs or on those that are susceptible to injury from the use of tar or creosote.

The statement has often been made, and very widely accepted, that it is not necessary to paint the scars made by cutting small branches, a half inch or less in diameter; but the writer has observed many instances where serious diseases have gained entrance through wounds that were considerably less than half an inch across. For thorough and careful work, particularly on choice trees or shrubs, the smaller scars should be as thoroughly treated as the larger ones.⁹ Care should be taken, however, that the waterproof covering is not applied to the surface of the uninjured bark adjoining the wound, as this may cause injury through partial asphyxiation.

CAVITY WORK.

When an injury or wound has been allowed to remain untreated for a year or more, decay-producing organisms are almost certain to have started an area of decay behind the exposed surface of the wood. If untreated, this area increases in size and depth as time passes, until in the course of years it so weakens the limb or tree that a storm may break it at the weak point, or the decay may have developed to such an extent that any attempt at treatment would be a waste of time and money. Such areas of decay often are aggravated and increased by the presence of insects, particularly borers and ants. All such regions of infection or decay must be attended to promptly if the best possible results are to be realized. Whatever may be the size of the decayed or diseased area or wherever it may be located, the first steps toward checking its progress are practically identical in all cases. They may be regarded as comprising two essential operations: (1) Excavating all decayed and diseased wood and (2) sterilizing and waterproofing all cut surfaces.

TOOLS.

The necessary tools for digging out the decayed wood are few. As a rule, two outside-ground socket-handled gouges,¹⁰ a chisel, a mallet, a knife, and an oilstone are sufficient for ordinary work.

⁹ Small scars near the tips of small branches are not usually a source of great danger, for if infection takes place it is possible to cut off the small limb farther back without seriously disfiguring the tree.

¹⁰ One gouge should have a curved cutting edge of about three-fourths of an inch and the other perhaps $1\frac{1}{2}$ inches.

The gouges, chisel, and knife should never be used on the bark or near the cambium when they lack a keen edge, as dull tools will injure the latter. In cutting out deep cavities, longer interchangeable handles for the gouges may be necessary. A ladder or a step-ladder will be required if the work is more than 5 or 6 feet from the ground. As the work progresses, the desirability or convenience of certain other implements will often become evident.

EXCAVATING.

Usually an old neglected area of decay may be partially or wholly covered at the edges by a comparatively recent growth of wood and bark, and the visible area of decay may be small as compared with the part which is hidden (fig. 8). Indeed, this is the usual condition. In such cases it often is necessary to enlarge the opening in order to have sufficient room in which to gouge out the interior.



FIG. 8.—Section of a tree with an old wound partially healed over, showing a large decayed area (a) with only a small opening (b) visible from the exterior. In excavating the decayed area the cavity should reach back in all directions into sound wood.

This opening should not be made any wider than is necessary, but it may be sufficiently long to reach all the decayed and diseased heartwood with little or no additional injury. If the decayed and diseased wood extends some distance above or below the external opening it will be necessary to lengthen this opening in order to reach all the diseased wood. The opening should be pointed at both ends.

The most important feature at this stage of the work is to remove all the diseased or insect-eaten wood. This excavating must continue on the sides and ends of the cavity until sound and uninfected wood is reached. All discolored or water-soaked wood should be removed, as this is the region in which the rot-producing fungi are usually most active. Infected wood usually extends some distance above and below the visibly discolored portion. In decayed areas of many years' standing there may be only a thin shell of healthy wood around the cavity, in which case there is danger of the tree being broken by storms unless braced or guyed, as mentioned later (pp. 25-27). Unless there is some very special reason for attempting to prolong the life of such a tree it is better to have it removed and replaced by a healthy one. If desired, a comparatively large tree can be moved in to replace it. In experienced hands the transplanting of large trees can now be done with reasonable assurance of success.

SHAPING THE CAVITY.

Whenever possible, the bottom and all other parts of the cavity should be shaped so that any water thrown into the cavity will run

out promptly and none remain in any hollow. When the cavity extends below the surface of the ground (rarely at other times), it is not possible to drain it in the manner mentioned. Under such conditions the lower part of the cavity should be filled to a few inches above the level of the ground and the top of the filling sloped so as to throw the water out of the cavity in case the whole cavity is not to be filled.¹¹

It is bad practice to have a deep water pocket at the bottom of a cavity with drainage provided through an auger hole bored from the exterior. An open hole of this sort usually becomes a favorable lodging place for insects, fungous spores, yeasts, and bacteria, any one of which may cause trouble.

As already emphasized, great care must be taken in working around the cambium, and all cutting tools must be kept very sharp. The final cutting along the edges of the bark and sapwood can often best be made with a very sharp knife or drawshave. This cutting must be followed immediately by a coating of shellac, which should cover the cambium and a narrow strip of the bark and adjoining sapwood (see p. 8).

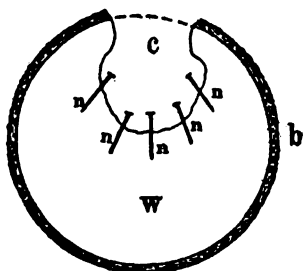


FIG. 9.—Section of a tree cavity, showing how it is undercut at the margins to assist in holding a plastic filling in place; it also shows nails driven into the back of the cavity for a similar purpose: *b*, Bark; *c*, cavity; *n*, nails; *w*, wood.

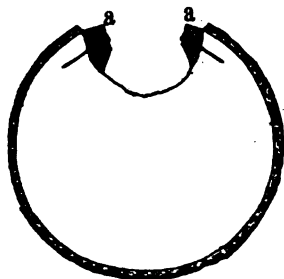


FIG. 10.—Section of a tree cavity, showing how strips of wood (*a*) can be nailed along the edges to prevent the inrolling of the new callus growth and at the same time to hold a plastic filling more firmly in place. In open cavities the back edge of the strip should be beveled, as indicated, so as to allow ready inspection of all parts of the cavity; in cavities to be filled the back edge should not be beveled.

UNDERCUTTING.

Another point to be borne in mind in shaping a cavity that is to be filled with cement, asphalt, or other similar substances is to have the sides undercut if possible (fig. 9), so as to hold the filling more firmly in place. Care must be taken, however, that the living wood at the edges of the opening is not very thin, as this promotes the drying out of the sapwood and bark at these points. Ordinarily the edges should be at least three-fourths of an inch thick ($1\frac{1}{2}$ inches is better). When possible it should include the full thickness of the sapwood. Inrolled bark at the edges of an opening should be cut away. If it is not possible to undercut sufficiently to hold

the filling firmly in place, the alternative method described under "Nailing or stapling" can be adopted, or one or more strips of wood can be nailed around the cavity, the outer surfaces of which are level with the cambium (fig. 10).

¹¹ Asphalt and sawdust (or sand) make one of the best mixtures to use in such places; see pp. 20-22).

STERILIZING THE CAVITY.

After the decayed and diseased matter has been completely excavated and the edges of the sapwood and bark adjoining the cambium shellacked, the remainder of the cavity also must be sterilized. As already stated (pp. 8-9), creosote appears to be one of the best generally known preparations to use. Every exposed part of the wood and bark must be sterilized, and over this a heavy coating of tar, hot asphalt, or some other suitable waterproof covering applied.

This completes all the essential operations in repairing and treating old decayed spots or freshly made injuries. Filling a cavity is of much less importance. Oftentimes a cavity is safer and better if left unfilled; it certainly is if cement is used and the work is done carelessly or ignorantly.

OPEN CAVITIES.

A tree cavity which has been excavated, sterilized, and waterproofed in the manner just described is in condition to be left, with occasional inspection, in comparative safety for years. Cavities treated in this way probably are safer than most tinned or cemented cavities of the ordinary sort, and, furthermore, they have the advantage of permitting easy inspection from time to time. The new growth of wood and bark along the margins will gradually form an inwardly rolled edge if there is no filling, sheet metal, or artificial ledge (see fig. 10) to force it across the cavity.

The cavity must be watched from year to year, and any tendency of the waterproof coating to crack, peel, or blister should immediately be counteracted by repainting. This is an important point, which must not be neglected. It is better and safer to repaint every year (or at least every two years) until healed over, without waiting for defects to appear.

TIN-COVERED CAVITIES.

Sheet tin, zinc, and iron have been used rather extensively to cover cavities. When properly applied, these coverings assist in keeping out disease, decay, and insects for a long time. If improperly covered or if the cavity itself is not properly treated, a metal-covered cavity is a much greater menace to a tree than an open one. In preparing a cavity for a sheet-metal covering, all the decayed, diseased, and insect-eaten wood should be removed in the manner already explained, with two modifications: (1) There is no necessity of undercutting the cavity and (2) there should be a narrow half-inch ledge of wood around the edge of the cavity from which the bark has been removed and to which the margin of the sheet metal can be tacked (fig. 11). The cavity must be thoroughly sterilized and waterproofed, as already described. The sheet metal should be trimmed so that its edges will fit closely along the edges of the live bark. This

can best be done by first making a heavy-paper pattern. The metal should be cut the same shape as the paper pattern and then placed on a block of wood and holes a half inch or an inch apart punched or drilled along its margin, through which long, slender, flat-headed brads may be driven into the ledge of wood around the cavity. The edges of the cavity and the inner side of the metal should be freshly waterproofed (the entire cavity already having been so treated). The metal should be put in place and nailed with a light hammer, allowing it to curve outward so as to conform to the general shape of the trunk or to curve inward. Two or more pieces of sheet metal with overlapping joints should never be used unless these joints are soldered air tight. If all insect tunnels have not been cut out, the cavity should be fumigated by saturating a wad of cotton or cotton waste with carbon disulphid¹² and suspending it with a string in the top of the cavity for 12 hours or more before the metal is permanently nailed to the wood at the top. During the fumigating process the cavity must be tightly closed. The final operation is to waterproof the outer surface of the metal, taking special care that the tacked edges are made as air tight and waterproof as possible. During all parts of the operation care should be taken that the cambium is not bruised or unnecessarily cut.

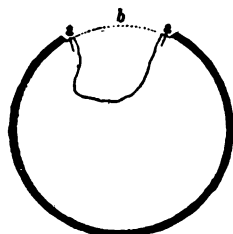


FIG. 11.—Section of a tree cavity, showing the marginal ledge of wood (a) to which a sheet of metal (b) can be tacked to cover the cavity.

BOLTING THE CAVITY.

If a long cavity is to be filled with cement or asphalt it usually is advisable to place through it one or more bolts to hold the wood and filling more firmly together. A cavity 2 feet or less in length will not usually require a bolt, but long cavities as a general rule should be bolted every 18 to 24 inches. Oftentimes a single bolt can be placed so as to support both sides (fig. 12). In certain cavities it may be necessary to place bolts at different angles (fig. 13). In any case a strip of uninjured bark and cambium at least an inch wide should be left between the edge of the cavity and the end of the bolt. On medium-sized trunks, after deciding where the bolts can most efficiently be placed, a sharp bit, a half-inch (or larger) in size and sufficiently long to reach through the trunk and cavity, can be used to bore the hole for the bolt. On large trunks a larger bit should always be used. Iron or steel washers (preferably oval) about three times the diameter of the bolt (fig. 14) should be countersunk into the wood by carefully cutting away the bark and wood at both ends

¹²Carbon disulphid should not be used near a fire or an open light, as under such circumstances it is explosive. See Farmers' Bulletin 799, entitled "Carbon Disulphid as an Insecticide."

of the hole. The washers should be heavy and ample, but not so broad as to necessitate cutting away an excessively large piece of bark. In most trees when round washers are used it is advisable to have the bark adjoining this countersunk area somewhat pointed above and below the washer (fig. 15), for reasons already mentioned. By holding the two washers in place, the length of the iron or steel

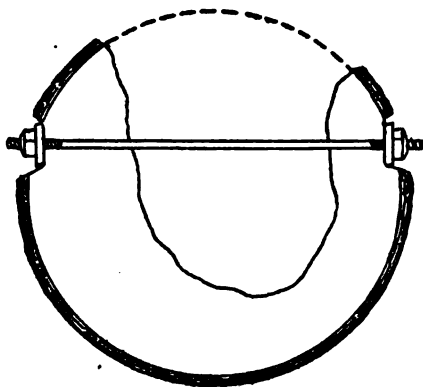


FIG. 12.—Section of a large tree cavity, showing how a single bolt should be placed to hold the sides rigid.

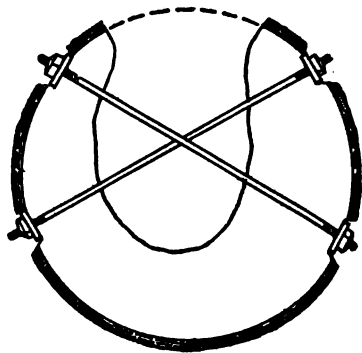


FIG. 13.—Section of a large tree cavity, showing how two bolts should be placed to hold the sides rigid.

machine bolt needed can be determined by measuring through the hole. The bolt must be thick enough to fit snugly in the hole and should project beyond each washer for at least a quarter of an inch. The thread at each end of the bolt must be coarse and sufficiently long to permit drawing in the sides of the cavity as the nuts are screwed up firmly against the washers. A chamfered single-headed bolt may be used, if preferred. Before the bolts are finally put in place the countersunk cuts and the bolt holes should be tarred or creosoted, and after the bolts are in place all exposed parts of the bolts and nuts should be waterproofed. If the washers and nuts are sunk deeply into the wood the holes at the ends of the bolts may be filled with cement or asphalt to the level of the cambium. This will make a neater looking job and leave the spot in better condition for healing.

All split cavities must be securely bolted, particularly near the upper part. If the split comes from a crotch, all decayed and diseased wood should be removed from the split and an antiseptic wash and waterproof coating applied, after which it can be bolted just beneath the crotch (fig. 16, *a*) so as to close the crack or at least bring the parts back to their normal position in case decayed matter has been excavated from the crack. If the split is a recent one, an antiseptic washing alone will usually be sufficient before drawing the

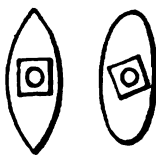


FIG. 14.—The ends of two bolts with oval washers. The long diameter of the washers should run lengthwise of the trunk or limb.

sides together with bolts. Under most conditions, particularly in large trees, it will be necessary to use a rope and tackle blocks some distance above the crotch to pull the limbs together so as to properly close the crack before bolting it. When tackle blocks are used care must be taken to have an abundance of bagging or other padding between the bark and the encircling ropes. Finally, all exposed edges of the crack must be thoroughly waterproofed. If necessary, limbs above split crotches may be guyed, as described later. If there is a cavity in the crotch, it should be cleaned and the limbs above it firmly guyed before the cavity is filled.

FILLING CAVITIES WITH CEMENT MIXTURES.

If desired, cavities made by excavating decayed material may be filled with any one of a variety of substances. The most important purpose of the filling is to prevent the new growth of wood and bark from curving or rolling into the cavity and not to strengthen the trunk, as many people suppose. At present the most widely used material for this purpose is cement, usually in the form of cement mortar or concrete. There are many theoretical and practical reasons why the use of cement should be avoided, or at least discouraged. The use of cement in long or large cavities, either in one solid piece or in sections, is not advocated. Under ordinary conditions such cavities had better be left open or filled with asphalt or wood. However, cement appears to hold fairly well in small or globular cavities in the trunk and larger limbs that are not easily bent by a high wind and in somewhat larger cavities about the base of the trunk or in the roots; that is, where there is little or no movement as the tree sways in the wind.

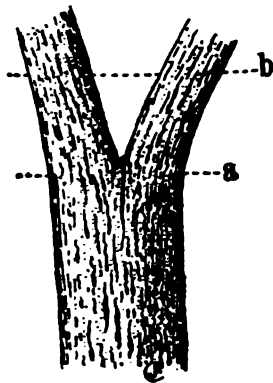


FIG. 16.—A split crotch; the dotted lines *a* and *b* indicate the position in which bolts should be placed to hold the split.

If for any reason it becomes necessary or desirable to fill a long or large cavity with cement, the cavity may be fitted with rods, bolts, or wires for reinforcing the cement when the latter has been placed in the cavity, or iron girders may be firmly bolted into the cavity to stiffen the trunk. There are various ways of reinforcing, the choice of methods depending largely upon the location, size, and shape of the cavity. One simple method of doing this is to drive heavy staples along the sides of the cavity, from 4 to 8 inches apart and 3 or 4 inches back from the cambium. Between these staples heavy wires are stretched across the cavity, crisscross or straight. Another simple method is to use



FIG. 15.—The end of a bolt with a round washer. Triangular pieces of bark should be cut away above and below the washer, as indicated by the broken lines.

a few iron rods, the ends of which are set into holes bored into the wood. Straight rods can be bent in order to insert the ends in the holes and then straightened, or one end of the rod can be bent at a right angle and the long end inserted in a hole at the top or bottom of the cavity and the short end in a properly located hole at the back or side of the cavity. One rod or several such rods may be used, as seems desirable. At other times it may be preferable to place a few bolts through the cavity. Bolts have the advantage of holding the sides of the cavity rigidly in place against the hardened cement. The bolts should be placed in accordance with the instructions given on pages 15 to 17.

The method of preparing cavities for filling with cement is the same as that already described (p. 12).

Nailing or stapling.—In a cavity with a comparatively large opening or with little or no undercutting it is common to drive flat-headed wire nails or large staples for half their length into the wood in the interior before inserting a plastic filling. In medium-sized cavities large staples or nails 2 or 3 inches long may be driven into the wood for about half their length (fig. 9). The loops of the staples or the heads of the nails finally are completely embedded in the hardened filling, thus preventing the filling from falling out of shallow cavities under ordinary strain.

Mixing the cement.—A good grade of Portland cement and clean sharp sand free from loam (1 part of cement to 3 or less of sand) should be used. The mixing can be done in a mortar bin, a wheelbarrow, a pail, or in any other available receptacle that is sufficiently large. A quantity of dry cement and sand sufficient to fill the cavity should be thoroughly mixed before adding water to make a stiff mortar and the whole mixture worked to an even and smooth, but not watery, consistency. In cavities a foot or more in diameter, fine gravel free from loam is sometimes substituted for the sand except near the outer surface.

Filling the cavity.—For placing the mixture in the cavity a mason's flat trowel and an ordinary garden trowel with a curved blade will be found convenient. A tamping stick 1 or 2 inches thick and 1 to 3 feet long, depending on the size of the cavity, will be needed. A layer of cement 2 or 3 inches deep can now be placed in the bottom of the cavity with the trowel and tamped firmly in place. This operation is repeated until the cavity is filled, the tamping being directed mainly toward the back of the cavity rather than downward. If the mixture is too moist, it will tend to run out at the bottom of the cavity under the operation of tamping. If too little water has been used, the mixture will be somewhat granular or powdery and will not pack down promptly. The remedies are obvious. If the interior of the cavity extends well above the level of the external

opening, it may occasionally be necessary to bore or cut a downward slanting hole from the outside to the top of the interior cavity, through which a watery mixture of cement may be poured to fill the upper part of the cavity and the hole. The main opening of the cavity must be completely closed with the stiffer cement and allowed to partially set before this watery mixture is introduced. When the cement has partially set, the outer surface should be carefully smoothed or cut down with the flat trowel to the level of the cambium, as shown by the dotted lines in figures 9, 12, and 13, taking great care that the latter is not injured in the operation. If the cement is allowed to set too firmly to trim with the trowel, it can still, with more or less difficulty, be cut back to the cambium line with a cold chisel and hammer.

The thinner mixtures of cement will set more firmly. If a mixture thinner than the one indicated above is used to fill a cavity, some sort of cloth or wire dam will have to be used to hold the cement in place until it is set. It may be convenient to use such a dam on all except cavities with small openings. One simple method is to wrap strips of burlap around the tree so as to cover the lower part of the opening, if the mixture is not very thin; otherwise, a more closely woven fabric, such as canvas or carpet, may be used. This dam at first should cover only the lower part of the opening, and should be loose enough to allow it to be pushed outward to about the normal contour of the trunk when the cement is tamped in place behind it. The cavity is filled with cement to the top of the dam and the height of the dam increased as becomes necessary by wrapping more cloth or wire about the tree without disturbing that already in position. After the cement has partially set but before it has become hard, the dam is removed and the surface of the cement trimmed back with the mason's trowel and finished in the usual manner. At times it is advisable to have wire netting of about a half-inch mesh or wires (or metal rods embedded in the cement) nailed to the sides of the cavity to reinforce the filling and hold it in place.

The edges of cement fillings in the crotches of limbs are especially difficult to keep water tight. Besides bolting the cavity and guying the limbs above it, the crevices at the edges of such cement fillings must be made as near absolutely waterproof as thick tar or asphalt or elastic cement can make them. A mixture of asphalt and sawdust is much better than cement to use as a filler in such locations.

After a cement filling has become thoroughly dry, the outer face may be painted with coal tar or paint. If cracks appear in the cement, or the wood draws away from the cement, or the work is not properly done, decay-producing organisms may gain entrance at the edge of the cement and cause serious trouble.

FILLING CAVITIES WITH ASPHALTUM MIXTURES.

For covering large wounds or for waterproofing cavities, asphaltum (commonly called asphalt) apparently is not equaled by any other substance that has been mentioned in this bulletin. The asphaltum referred to is a product of the distillation of some of the western petroleums and varies in melting point from the boiling point of water upwards. The greatest objection to its use is the fact that it has to be kept melted and used while hot. This makes the process cumbersome and inconvenient, which in itself is a serious objection from many points of view, although a coating of asphalt, properly applied at the outset, will often last for years without special attention. For normal scars it should be used clear and applied with a swab or small whisk broom.

As an efficient cavity filler asphalt has few of the objections found in cement, because its elasticity and resilience prevent cracking and it is absolutely waterproof. It is very adhesive and does not readily separate from the wood when properly applied. For filling a cavity it should not be used clear but in combination with dry sawdust, wood pulp, excelsior, shavings, sand, or some other substance.

An outline of two methods of using a mixture of asphalt and sawdust to fill a cavity will serve in general for the other mixtures mentioned. The first method will be most useful when a fire or stove can be used near the tree, and the second where this is impracticable, as, for example, on a well-kept lawn or near shrubbery that might be scorched by the heat.

First method.—Thoroughly melt the asphalt in a kettle or other suitable receptacle and slowly stir in the dry sawdust. Continue adding the sawdust as long as the particles are blackened by the asphalt after a few moments' stirring. This hot pasty granular mixture can then be placed in the cavity, which has been prepared as already described, and pressed or tamped into close contact with the side of the cavity before it hardens or cools. For placing the mixture in the cavity, which already has been waterproofed with clear hot asphalt, a trowel, paddle, or ladle can be used. The tamping stick should have a smooth and slightly rounded end. The end may be covered with sheet metal if desired, or a tamping rod made of iron may be used. If the mixture adheres to the end of the tamping stick to an extent that interferes with the work, a quick twist, as it is about to be withdrawn, will usually improve conditions. It may be necessary to grease or wet the end of the stick frequently. Often the best results are realized when a steady slow pressure is exerted rather than a quick tamping movement. A very excellent 2-foot tamping stick can be made from a shovel handle. The grip at the end gives a ready purchase for the twisting motion. The opposite end of the stick should be rounded, sandpapered, and soaked for some hours in a lubricating oil or in hot tallow before using.

Second method.—Mix the asphalt and sawdust in a kettle, as described under "First method," over any suitable stove or fire and at any place where it may be most convenient. When thoroughly mixed, dip it out of the kettle and place it on sheet metal to cool in the form of pancake-shaped or biscuit-shaped lumps, whichever form may be the most conveniently used or handled. The sheet metal may be greased or not. The asphalt mixture can be removed when cold by applying a blast torch

to the back of the sheet metal if necessary. Another and often more convenient way of preparing the lumps is to drop the hot mixture into molds made in the ground or in sand and brush off the dirt or sand when the lumps are cold. These lumps of asphalt and sawdust can then be transported wherever they are to be used, or they can be stored indefinitely for future use. When filling a cavity they may be used whole or broken into pieces. A blast torch may be used to soften the surface of the lump before it is pressed into place in the cavity and nailed firmly to the wood, or the lump may have nails driven into it and then partially or completely dipped into melted asphalt and immediately nailed into the cavity. All the lumps should be nailed firmly in place. Small sheets of wire netting, burlap, or canvas often can be nailed or stapled over different layers of the asphalt mixtures with good results; preferably so they will not show on the surface when finished. This operation, perhaps with slight modifications, is repeated until the whole cavity is filled. When the blast torch is used in the interior of the cavity care should be taken that the cambium is not overheated.¹³

After all the decayed matter has been removed and the cavity sterilized and waterproofed, there is no immediate danger in delaying subsequent operations if for any reason such delay seems necessary or desirable. Moreover, it is unnecessary to put all the filling compound into the cavity the same day, or the same week, or even the same month. After asphalt mixtures have cooled, the hot sticky surface can be restored by passing a hot iron over it or by protecting the cambium and using a blast torch. This melting of the surface should be done just before another batch of filling is added, especially when the first method mentioned is used.

When a cavity has been filled by either method, the surface of the filling can be finished off with a hot iron to the level of the cambium, as shown by the dotted lines in figures 9, 12, and 13. If a sufficient quantity of sawdust has not been mixed with the asphalt or if too much clear asphalt has been used to cement the lumps together when the second method is used, the composition will invariably settle away gradually from the top of the cavity. To prevent this, the surface of the finished filling should be covered with canvas, closely woven burlap, thin strips of wood, wire netting, sheet metal, or other suitable covering, and held in place with long nails, screw bolts, or staples that reach into the solid wood at the back of the filling.¹⁴ In shallow fillings a simple way is to drive in closely set long nails, each nail passing through a large metal washer. As a rule, if these washers are closely set no other covering is necessary. When any of these surface coverings are used the outer face should be no higher than the level of the cambium and should be waterproofed with tar, asphalt, or paint.

Care should be taken to avoid bruising or unnecessarily heating the cambium at any time. A very good tool with which to finish the raw

¹³ One simple way of preventing this overheating is to have a broad flexible paddle of wood, fiber, or other nonconductor of heat that can be held over the cambium and bark with one hand while the torch is being used with the other. After a little practice the torch will rarely have to be used inside the cavity.

¹⁴ If the bolts, nails, or staples are too thick to be driven through the asphalt without cracking it, they can be heated and slowly pushed through to the wood.

surface near the cambium is a small mason's trowel, the tip of which can be heated for a few seconds at a time in the flame of a blast torch. A tool of this general shape with a thin edge but with more metal at the center is better and will hold the heat longer. For finishing farther away from the cambium, a larger and heavier tool will be more useful; an old-fashioned flatiron does this work efficiently and can be used for this purpose if nothing better is available. If masses of asphalt project too far beyond the contemplated finished surface to be smoothed readily with a hot trowel, they can be cut off with a hot trowel or with a cold chisel and hammer before the surface receives its final smoothing.

Under certain conditions asphalt and sawdust or asphalt and sand, used in combination with cement blocks or with wood (see next heading), will be better than either used separately, and they often are more economical

FILLING CAVITIES WITH WOOD.

Asphalt can be used along with chips, larger blocks, or strips of dry wood (such as laths or scantlings) for filling cavities. When blocks or strips of wood are used as the main filling substance they can be trimmed to fit into various parts of the cavity or the whole cavity and nailed in place. A good way to do this is to trim a block or strip roughly to fit the desired place, then remove it from the cavity and drive the required nails or staples part way through it. At times it may be advisable to use screws or bolts instead of nails or staples. The back of the block or strip and that portion of the cavity in which it is to be placed should be covered with a thick coat of hot asphalt or almost any of the mixtures mentioned above, except perhaps asphalt and chips, and the strip nailed in place. A long heavy nail set (or center punch or saddle punch) will be useful in driving the nails or staples into the strips. The blocks or strips of wood need not be very carefully fitted, because the asphalt mixtures, particularly asphalt and sawdust, will fill practically all spaces between them. Preferably the grain of the blocks or strips should run lengthwise of the trunk and extend the entire length of the cavity, at least when near the surface. In large cavities a strip or layer of strips an inch or two thick can first be placed in the back of the cavity and then the building up done mainly from the sides (fig. 17). If the filling is planned so that there will be an unnailed but thoroughly asphalted closely fitting joint extending the length of the cavity and from the outer surface back to the layer of strips first nailed to the back of the cavity (see fig. 17, *a-c*), there will be practically no danger of the filler pulling away from the sides of the cavity as a result of a sudden drop in temperature and consequent contraction of the sapwood. In such a filling the opening, if it comes, will be along the line of least resistance, which in this case will be, almost invariably, the unnailed joint lengthwise of

the filling. In section this joint may be a straight or a zigzag line, preferably the latter. As the crack closes, the asphalt will usually cement the two edges of the joint together again; but even if it does not, both surfaces of the crack still will be covered with waterproof asphalt.¹⁵ If the strips of wood used in the cavity are creosoted before they are put in place, the danger of infection as a result of wetting is still further reduced. The exposed surface of the completed filling should be smoothed off at the level of the cambium, so as to conform more or less closely with the shape of the trunk (fig. 17), and finally painted with hot asphalt, coal tar, or paint of any desired color.

For keeping the asphalt melted some sort of heater will be required. In most cases one that is readily portable will be most useful, for the asphalt can usually first be melted over some less portable heater or stove and the portable heater used merely to keep the asphalt melted while it is being used. Often it will be most convenient to have a rather small heater, such as some blast torch or a plumber's or tinsmith's stove; possibly one that can be suspended by a padded wire from a limb of the tree. A galvanized-iron pail with a capacity of about 10 quarts may be useful for this purpose. The bail socket should be riveted to the pail. With a little ingenuity one of the heaters mentioned above can be altered so that it can be suspended by means of two long hooks to the bail sockets of the pail or to the top of the pail and the pail and the attached heater carried about by the bail, yet the two can readily be separated if desired. The pail and heater can be suspended from the limb of a tree by a padded hook, or the heater can stand on a board on the ground and the pail be set on top of it.

Oftentimes it is neither necessary nor desirable to completely fill a cavity; or perhaps the necessary time to complete the work promptly is not available. Under such conditions the cavity can be cleaned out, sterilized, and waterproofed and then strips of waterproofed wood nailed along the edges of the cavity, the outer edge of the strip being at the cambium line (fig. 10). In most cases if this strip is a half inch thick it will serve for some time to prevent the new callus wood and bark from rolling inward into the cavity, and before the new growth has reached across it another strip can be nailed over it or the cavity completely filled, perhaps with asphalt

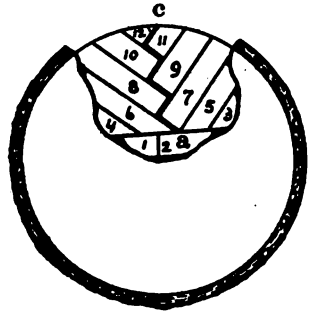


FIG. 17.—Section of a tree cavity filled with strips of wood. The numbers on the strips indicate the order in which they are inserted. No nails are driven across the zigzag line a-c.

¹⁵ If the wood strips used are soft or easily split, it will be safer to use coal tar in this joint, as cold asphalt will sometimes cause the wood to split before the asphalt will yield. If the wood should split, the crack should be filled with coal tar.

and sawdust. If this method is followed it will be necessary temporarily to fill and waterproof the small pocket back of the strips at

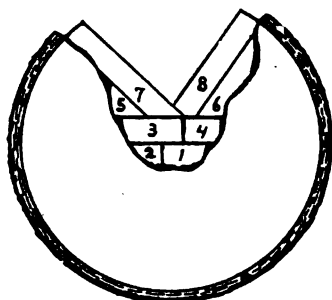


FIG. 18.—Section of a tree cavity partially filled with strips of wood. The numbers indicate the order in which the strips are inserted.

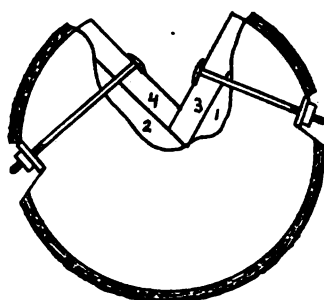


FIG. 19.—Section of a tree cavity partially filled with strips of wood; these are bolted to the walls of the cavity. The numbers indicate the order in which the strips are inserted.

the bottom of the cavity, using wood or some plastic substance so that it will not hold water.

If it is impracticable or inconvenient to use hot asphalt and sawdust between the strips of wood in filling a cavity a substitute can be found by mixing sawdust with creosote and asphalt,¹⁶ or with coal tar, or even with paint. When any of these mixtures is used the strips of wood may have to be trimmed to fit more closely, as such mixtures will not so readily and permanently fill large spaces between the strips as will the thicker asphalt mixtures. Perhaps the best general substitute for the heavy asphalt is a mixture of coal tar and sawdust. This mixture does not necessarily have to be heated during any part of the operation unless the work is done in very cold or freezing weather. It is better, however, to have the tar hot when the sawdust is mixed with it. No definite proportion for the tar and sawdust can be recommended, because the quantity of each ingredient is largely dependent upon the grades of sawdust and tar that are used. In his own work the writer has found that 1 part of dry sawdust by weight to 3 or 4 of coal tar or 3 to 4 parts of dry sawdust by bulk to 1 of coal tar gives a mixture of about the right proportions. The mixture should be stirred (preferably when

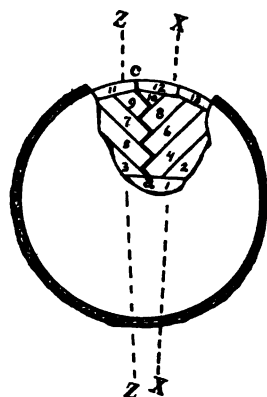


FIG. 20.—Section of a tree cavity filled with strips of wood, with a thin surface layer of strips (11, 12, 13). The broken line x-x indicates where a bolt, when necessary, should be located to hold the ends of a filling, as indicated in figure 21. Occasionally it may be necessary to place bolts at both x-x and z-z. No bolt should pass through the unnailed zigzag joint a-c.

¹⁶ For directions for mixing creosote and asphalt, see p. 9.

warm) until it is of an even consistency—somewhat granular but sticky and pasty. When put in the cavity it should stick there after a little pressure or after tamping with an oiled or moistened stick, but should not be thin enough for the tar to ooze out, at least not until the mixture is compressed by nailing or stapling the wood strips firmly in place over it. It will be advisable to paint the exposed wood, the strips that have been fastened in the cavity, and the back of the strip that is to be inserted, using clear coal tar, before inserting the sawdust and tar mixture.

Generally some such arrangement of strips as is shown in figures 17, 18, and 19 will be found most advantageous in most cavities, as such an arrangement usually permits greater freedom in driving the nails or staples or in placing the screws or bolts in position through the strips. The edge of the strips at the surface should be trimmed off in a line with the cambium, as shown in figures 17 and 21, or the strips may be trimmed back to a line behind the cambium and one, two, or more thin strips of sufficient thickness to bring the surface to the cambium line nailed, screwed, or bolted over it to form an outside layer, as shown in figure 20. The order in which the strips should be placed in the cavity is indicated by the order of the numbers in figures 17, 18, 19, and 20. In long fillings, particularly in flexible branches, a bolt and metal washer near each end of the filling and another at the center will prevent the ends or center working loose. Figures 19, 20, and 21 with their legends will explain the details of placing the bolts and washers.

GUYING.

Closely associated with the work already described, and often an indispensable adjunct, is the guying of limbs to prevent the splitting of the crotches or to check splitting that has already started.

A simple method of guying a crotch is to place a hook or ring bolt through each limb, with the hooks or rings in the two limbs toward each other and from 3 to 10 feet or more above the crotch (depending upon the size, position, and length of the limbs), and to tie these hooks by means of a strong wire, wire cable, or chain (figs. 22 and 23). Three or more adjoining limbs may be guyed collectively. The

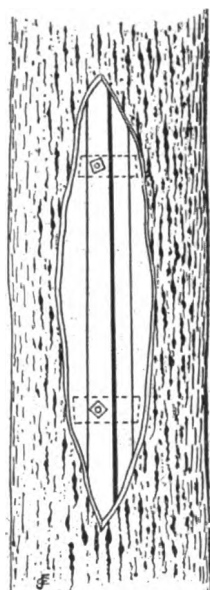


FIG. 21.—Surface view of a tree cavity filled with strips of wood, as shown in section in figure 17; the surface has not yet been waterproofed. The broken lines show the position of the bolts and the broad washers. The washers should be of heavy iron and wide enough to reach across all the strips at the point where they are placed. The bolts should not pass through the un-nailed joint (a-c) indicated in figures 17 and 20.

precautions already mentioned on pages 15 and 16 should always be followed, so far as they apply to boring and tarring the hole and countersinking the washers of the bolts.

A turnbuckle rod or bolt is often better than a cable or wire when the guy is to be kept perfectly taut at all times. Furthermore, the rod or bolt permits a ready tightening of the guy within certain limits, should it later become advisable. If for any reason the guy is to be placed within a foot or two of the crotch, a single long bolt can often be used to better advantage, and sometimes a single long bolt can be used in place of a cable, a chain, or a turnbuckle rod where the guyed limbs are not likely to twist much as they sway in the wind.

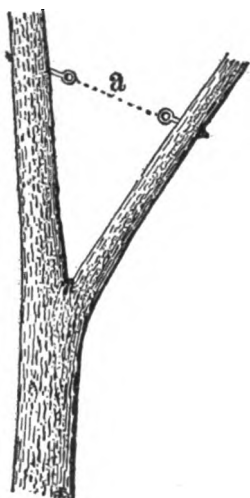


FIG. 22.—Side view of limbs, showing the proper method of guying them above a weak or split crotch. The wire, cable, or chain guy is shown at *a*.

Occasionally it may become necessary to guy a whole tree in order to prevent the breaking of the trunk when an unusually large cavity leaves only a thin shell of sound wood or to prevent a tree that has recently been set from tipping over before its roots have become well established. This can be accomplished by attaching four guy wires or ropes to the tree about half way from the ground to the top of the tree and having these slant downward at an angle of about 45° to four stout posts set firmly in the ground about equidistant around the tree (e. g., on the north, east, south, and west sides of the tree). If the guying is for temporary purposes only, two broad bands of leather or stout canvas or other strong material, each long enough to make a loop at least twice the diameter of the trunk or limb to be encircled and 4 to 6 inches wide, may be passed around the tree or some favorably situated limb and two adjoining guys attached to each loose loop. If a permanent guying is needed, two eyebolts (or hook bolts) can be placed through parallel creosoted holes in the trunk or limb about halfway up the tree, one 6 inches or more above the other. The eye of one bolt should be on the opposite side of the tree from the other. Two guys from two adjoining posts are attached to each eyebolt, the latter pointing halfway between the two posts to which the guys are to be attached (fig. 24). The chafing of a limb against a guy should be prevented by padding the guy wire with a piece of garden hose or the limb with burlap, if the guy can not be so placed or braced as to clear all limbs.

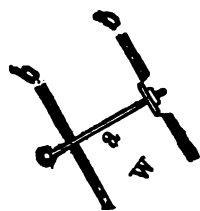


FIG. 23.—Sectional view of the limb of a tree, showing the details of placing an eyebolt of the type shown in figure 22: *a*, Bolt; *b*, bark; *w*, wood.

Limbs or trees should never be guyed by passing wires, chains, or ropes tightly around them. These may eventually strangle the portions above the encircling band. Encircling fence wires, telegraph wires, or clotheslines may act in the same way, killing all parts of the tree beyond the ligature if they remain tightly drawn around the limb or trunk for any great length of time—often in less than a year.

WHEN REPAIR WORK MAY BE DONE.

As a general rule, tree surgery can be undertaken safely at almost any time of year when the sap is not running too actively and the weather is not cold enough to freeze cement, if this is being used. In most trees the sap will interfere with the work only while the buds and leaves are expanding in the spring. Cement work will be ruined if it is frozen before it is set. It is not likely to be injured by frost after setting for a few days.

WHAT TREES ARE WORTH REPAIRING.

Most trees with only a few dead limbs are unquestionably worth attention. Others that have many dead limbs or decayed areas may not be worth the expense of repairing them, particularly if they are rapid-growing short-lived trees. This point should be considered very carefully before any repair work is undertaken. In any event a diseased or insect-infested tree should not be allowed to remain as a menace to near-by trees which are in a more healthy condition or entirely healthy. It should have all diseased or insect-infested bark, wood, or leaves removed and all freshly cut surfaces properly treated, or the entire tree should be removed. The diseased portions should be burned immediately. No one can decide better than the owner whether a tree is worth the expense of trying to save it, because the actual commercial value of an ornamental or shade tree usually has nothing to do with the decision. It is generally a question of esthetic value, or historic associations, or rarity of species. A man who has had experience in repairing mutilated or diseased trees may be able to say definitely whether it is possible to save the tree, but the owner, who has to pay the bill, is the one who will have to decide whether the tree is worth the cost of repairing it. Often the owner will be better satisfied in the end to have a badly diseased or mutilated tree replaced by a healthy perfect one. In expert hands the moving of large trees is no longer a hazardous undertaking.

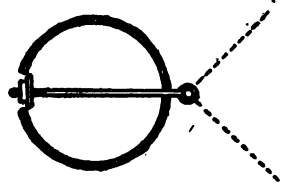


FIG. 24.—Sectional view of a tree trunk, showing the details of placing bolts for permanently guying a tree to the ground. This method of placing a bolt is used also in guying three or more limbs together. The broken lines indicate the guy wires.

COMPLETED WORK NEEDS WATCHING.

With the completion of repair work tree owners often fail to realize the importance of keeping close watch of their trees in order that defects which appear in the work may be remedied promptly and that new injuries elsewhere on the tree may have immediate attention. If a tree is of sufficient value to warrant proper and careful treatment, it certainly is worth the slight expense of subsequent annual or biennial inspection and the immediate repair of newly discovered injuries at a time when the expense necessary to keep the tree in good condition will be comparatively small.

PERSISTENCE OF SCARS.

It should be borne in mind that scars where large limbs have been removed or large cavities filled will be unsightly spots for years, even under the best of conditions. If the scar is a large one, it may never entirely heal over and consequently may remain a permanently conspicuous defect. It might so happen that a particularly large scar or filling would be too unsightly and conspicuous to please the owner. Here, again, greater satisfaction may be realized in the end by having the diseased tree replaced with a healthy one.

COMMERCIAL TREE-SURGERY WORK.

If a tree owner prefers to employ a commercial tree surgeon to attend to his trees it is well to have a definite written contract concerning at least certain important phases of the work, in addition to specifying the price and methods of payment. Besides the type or types of filling to be used in cavity work the following are suggested as points to be incorporated in the contract:

- (1) No climbing spurs shall be used on any part of a tree.
- (2) The shoes worn by the workman shall have soft soles.
- (3) In cavity work all diseased, rotten, discolored, water-soaked, or insect-eaten wood shall be removed and the cavity inspected by the owner or his agent before it is filled.
- (4) Ordinary commercial shellac shall be applied to the cut edges of sapwood, bark, and cambium within five minutes after the final trimming cut is made or as soon afterwards as the surface becomes dry.
- (5) All cut surfaces shall be painted with shellac or commercial creosote, followed by thick coal tar or asphalt.
- (6) The contractor shall repair free of expense any defects that may appear in the work within one year.

Under certain conditions various modifications of these suggestions may be advisable, but alterations in Nos. 1, 2, 3, and 6 should be made with caution. If certain crotches are split or particular limbs on some trees need guying, it may be well to include these items in the contract. At times it may be desirable to include a statement of

just what limbs shall be removed from particularly choice trees, and some provision should always be made for the regular inspection of the trees every one or two years unless the owner prefers to do this himself. The best results can generally be attained when payment is based upon the amount of work done, plus the cost of material used. Probably most persons, however, will prefer to have the trees examined and a definite contract price agreed upon before any work is undertaken.

CONCLUSIONS.

At present tree-repair work has not received the recognition and approval from tree owners that it deserves. This may be due at times to unfavorable experiences with dishonest or ignorant tree surgeons, at other times to the reluctance of the owners to spend much money in preserving their trees, or from their ignorance of the benefits that may result when tree-repair work is properly done. Reliable tree surgeons are doing much in a practical way to educate the public as to the benefits of tree-repair work. Unfortunately, the unscientific or dishonest work of some others still is doing much to offset it.

A few States have laws regulating tree-repair work on a commercial basis. This is a decided step toward the betterment of tree-surgery methods.

The Department of Agriculture invites correspondence concerning methods in tree-repair work and will be prepared to advise for or against any particular method so far as experience and the results of experiments will permit. By cooperation of this sort tree-repair work ought ultimately to deserve and attain a much higher position in the estimation of the general public than it now holds.

Finally, tree owners are urged to remember at all times that the necessity of tree-repair work 15 or 20 years hence may be reduced very materially by promptly attending to the fresh injuries of to-day.

PUBLICATIONS ON ALLIED TOPICS AVAILABLE FOR DISTRIBUTION.

No publications are sold by the Department of Agriculture; therefore do not send money to this Department.

Copies of publications listed herein will be sent free upon application to the Chief of the Division of Publications, Department of Agriculture, Washington, D. C., as long as the supply lasts. The editions of some of these listed are exhausted.

When the Department supply is exhausted, available publications can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., by purchase only and at the prices noted here.

Send all remittances to the Superintendent of Documents direct. His office is not a part of the Department of Agriculture.

- Blister Rust, White Pine. Pp. 15, pl. 1, figs. 5. (Farmers' Bulletin 742.)
- Cedar, Red, Diseases. Pp. 22, pls. 7, figs. 3. (Division of Vegetable Physiology and Pathology Bulletin 21.) Price 10 cents.
- Chestnut Bark Disease. Pp. 10, pls. 4. (Separate 598, Yearbook for 1912.) Price 10 cents.
- Chestnut Bark Disease, Control. Pp. 24, figs. 4. (Farmers' Bulletin 467.) Price 5 cents.
- Chestnut Bark Disease, Extent and Importance. (Forestry, Miscellaneous Publication.) Price 5 cents.
- Chestnut Bark Disease, Japanese, Immunity. Pp. 4. (Bureau of Plant Industry Bulletin 121, part 6.)
- Chestnut Bark Disease, Status. Pp. 14, pl. 1, fig. 1. (Bureau of Plant Industry Bulletin 141, part 5.)
- Chestnut Timber Killed by the Bark Disease, Uses. Pp. 24, figs. 8. (Farmers' Bulletin 582.) Price 5 cents.
- Chestnuts and Oaks, Death of, Due to *Armillaria mellea*. Pp. 9, pls. 2. (Department Bulletin 89.) Price 5 cents.
- Coniferous Nursery Stock, Blights of. Pp. 21. (Department Bulletin 44.) Price 5 cents.
- Coniferous Seedlings, Damping-off, Control. Pp. 32, pls. 2, fig. 1. (Department Bulletin 453.)
- Coniferous Seedlings, Damping-off, Treatment. Pp. 8. (Bureau of Plant Industry Circular 4.) Price 5 cents.
- Crown-Gall of Plants, Cause and Remedy. Pp. 215, pls. 36. (Bureau of Plant Industry Bulletin 213.) Price 40 cents.
- Crown-Gall, Plant Cancer, Structure and Development. Pp. 61, pls. 109, figs. 2. (Bureau of Plant Industry Bulletin 255.) Price 50 cents.
- Disinfectants, Injury to Seeds and Roots in Sandy Soils. Pp. 35, pl. 1, figs. 2. (Department Bulletin 169.) Price 5 cents.
- Farmstead, Beautifying the. Pp. 65, figs. 66. (Farmers' Bulletin 1087.)
- Forest, Hardwood, Northern: Its Composition, Growth, and Management. Pp. 80, pls. 15, fig. 1. (Department Bulletin 285.) Price 20 cents.

- Fungi, Mushrooms and Other Common. Pp. 64, pls. 38, fig. 1. (Department Bulletin 175.) Price 30 cents.
- Fungicides and Their Use in Preventing Diseases of Fruits. Pp. 32, figs. 17. (Farmers' Bulletin 243.) Price 5 cents.
- Home Grounds, Beautifying the. Pp. 24, fig. 8. (Farmers' Bulletin 185.) Price 5 cents.
- Jack Pine, Pathology, Observations. Pp. 10, pl. 1, figs. 4. (Department Bulletin 212.) Price 5 cents.
- Larch Mistletoe: Some Economic Considerations of Its Injurious Effects. Pp. 27, figs. 13. (Department Bulletin 317.) Price 5 cents.
- Mistletoe Injury to Conifers in the Northwest. Pp. 39, pls. 4, figs. 27. (Department Bulletin 360.) Price 15 cents.
- Mistletoe Pest in the Southwest. Pp. 39, pls. 2, figs. 7. (Bureau of Plant Industry Bulletin 166.) Price 10 cents.
- Pine, Disease Caused by *Cronartium pyrifforme*. Pp. 20, pls. 2, fig. 1. (Department Bulletin 247.) Price 5 cents.
- Pine, White, European Currant Rust. Pp. 4. (Bureau of Plant Industry Circular 38.) Price 5 cents.
- Pruning. Pp. 35, figs. 25. (Farmers' Bulletin 181.)
- Red Gum, Sap-Rot and Other Diseases. Pp. 37, pls. 8. (Bureau of Plant Industry Bulletin 114.) Price 15 cents.
- Slash, Rotting in Arkansas, Investigations. Pp. 15. (Department Bulletin 496.)
- Smelter Fumes, Injury to Vegetation. Pp. 23, pls. 6, fig. 1. (Bureau of Chemistry Bulletin 89.) Price 5 cents.
- Smelter Wastes, Injury to Vegetation and Animal Life. Pp. 63, pls. 9. (Bureau of Chemistry Bulletin 113.) Price 10 cents.
- Street Trees. Pp. 58, figs. 37. (Department Bulletin 816.) Price 15 cents.
- Timber Rot Caused by *Lenzites sepiaria*. Pp. 46, pls. 4, figs. 3. (Bureau of Plant Industry Bulletin 214.) Price 10 cents.
- Timber Storage Conditions in Eastern and Southern States with Reference to Decay Problems. Pp. 43, pls. 10, figs. 41. (Department Bulletin 510.) Price 20 cents.
- Tree Surgery, Practical. Pp. 28, pls. 7. (Separate 622, Yearbook for 1913.) Price 10 cents.
- Walnut Blight in the Eastern United States. Pp. 8, pls. 2. (Department Bulletin 611.) Price 5 cents.



#1. 9:1178 Revised

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1178

TREE SURGERY



THIS BULLETIN is intended primarily as a guide for those who desire to take care of decayed or injured places on their own trees or to superintend such work. It outlines some of the better methods of treating injuries, removing dead or diseased limbs, and repairing decayed spots in the trunk or limbs.

A badly diseased or injured tree should be removed and replaced by a healthy one unless there is some very special reason for trying to preserve the tree. This applies particularly to an old tree that has been in poor condition or in poor soil for some years. Such a tree rarely recovers completely from the shock of extensive or elaborate repair work on the trunk; in fact, it often deteriorates more rapidly thereafter.

Two axioms of tree-repair work (tree surgery) that should be borne in mind constantly are (1) that prompt treatment of freshly made wounds is the surest and most economical method of preventing disease or decay in the future and (2) that all wounds made in tree-surgery work should be cleaned, sterilized, and protected from infection just as thoroughly as in the case of animal surgery and for exactly the same reasons.

Most persons can, at least with some preliminary practice on the simpler types of work, undertake any of the work here outlined, provided they are familiar with the use of a gouge and mallet, a saw, and a paint brush. A steady head and ability to climb will be necessary for work in the top of a tree.

TREE SURGERY.

J. FRANKLIN COLLINS, *Forest Pathologist, Investigations in Forest Pathology,
Bureau of Plant Industry.*

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THE DANGER OF NEGLECTED WOUNDS.

INJURIES of various sorts are so common on trees that most people have become oblivious to the danger arising from neglected wounds, or at least they underrate the danger. Every broken limb and every wound that penetrates as far as the inner bark may become the point of entrance of active plant or animal parasites or rot-producing organisms unless these injuries are promptly and properly treated.

The best, safest, and most economical means of preventing future extensive decay, disfigurement, or premature death of a tree, is to attend to each injury as soon as it occurs. This kind of work is simple and comparatively inexpensive. If an injury is allowed to remain untreated for some years (as commonly happens), decay-producing organisms almost invariably enter the wound and produce a rotted area in the wood beneath, often of such an extent that a violent wind may break the tree at the decayed and weakened spot. Uninjured bark or an injured area promptly and properly treated usually prevents the entrance of decay organisms.

If an untreated wound of several years' standing has developed a considerable area of decayed wood or bark, the first question to be considered is whether the tree is of sufficient value to warrant the expense of repairing it properly. Should it be decided to repair the tree, the too common mistake of neglecting such portions as

are difficult to reach must not be made. A thorough, complete, and sanitary job should be made, or else nothing whatever attempted. If a tree is badly decayed or injured, it is best and safest to remove it and set a healthy one in its place; or it may be braced to prevent breakage in a violent storm; or it may have the decayed matter removed and the cavity treated in accordance with directions given in this bulletin. Trees from which large areas of rotted wood have been excavated and the cavities filled, or left open, will rarely completely heal over except under the most favorable conditions. Care-

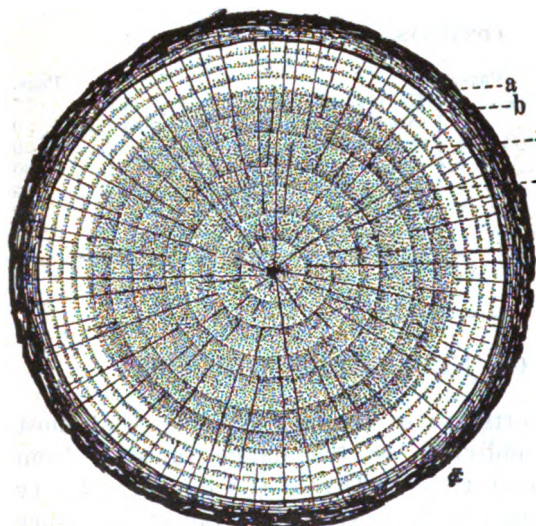


FIG. 1.—Cross section of a typical tree trunk, showing the various parts: *a*, Bark; *b*, cambium; *c*, sapwood; *d*, heartwood. The concentric rings in the sapwood and heartwood are the annual rings. The radial lines extending part way or entirely from the center to the bark are the pith rays. In this figure the outer and inner bark are represented as approximately equal in thickness.

ful and thorough cavity work on the trunk of a tree is of much greater importance than on a limb, as the latter often may be cut off well behind the diseased area without materially impairing the general health of the tree.

Many people fail to realize the full extent to which properly located, healthy, and well-kept trees will enhance the value of real estate, particularly for residential use. From this point of view alone, it is wise to keep the trees in a healthy and vigorous condition. Oftentimes historical associa-

tion, scientific value, or rarity of the species outweighs all other considerations. Trees unquestionably are a real asset from various points of view and for reasons too well known to need mention here.

When owners of trees realize more fully than at present that it costs comparatively little to properly treat injuries at the time they are made and that such treatment means much to the health, beauty, usefulness, and value of the trees in years to come, they will have learned the greatest economic lesson connected with the care and repair of trees.¹

¹ For advice in selecting trees and shrubs for the home grounds, see Farmers' Bulletins 185 and 1087 and Department Bulletin 816.

THE CAMBIUM.

The trunk and branches of a tree are made up of a cylinder of wood surrounded by bark. (Fig. 1.) Between the bark and the wood on healthy parts of the tree there is a very thin continuous layer of young (embryonic) tissue, which is not necessarily sharply marked off from either wood or bark. This is the cambium. (Fig. 1, *b*.) It is this layer that splits or slips so easily in the springtime, when the bark is removed to make the familiar willow whistles of boyhood days. During the growing season its microscopic elements (cells) are constantly dividing and giving rise to new layers of cells on both sides, on the outer side of the cambium to new layers of bark, on the inner to new layers of wood. Thus, the youngest layers of both wood and bark are those adjoining the cambium. As the cambium is a very tender and thin-walled tissue, a comparatively slight injury will kill portions of it, and once killed the dead area never again can give rise to new bark or new wood. However, the healthy living cambium around the edges of the dead area will give rise each year to a new layer of more or less abnormal wood and bark, unless its growth is retarded by disease or subsequent injury. Under normal conditions these new layers of wood and bark (called callus wood and callus bark) grow out each year over the margin of the dead area a little more than the width of an annual ring (see Fig. 1), and eventually the dead area, if not too large, may be entirely overgrown or hidden from view. Such dead spots furnish favorable points for the entrance of insects and organisms causing decay unless they are properly treated.

All new layers of the normal wood and bark of roots, trunk, and branches originate in the living cambium, never elsewhere; consequently, it is of the utmost importance to keep the cambium in a healthy and uninjured condition at all times. Diseases or injuries that kill large portions of the cambium usually are fatal to the tree.

REPAIR WORK.

In repair work (tree surgery) a few fundamental principles must be observed in order to secure permanently good results. These may be summarized briefly as follows:

- (1) Remove all dead, decayed, diseased, or injured wood or bark. When on a limb this can often be done best by removing the entire limb; on a large limb or on the trunk it may mean at times digging out the decayed matter so that a cavity is formed.

- (2) Sterilize all cut surfaces.

- (3) Waterproof all cut surfaces.

- (4) Leave the work in the most favorable condition for rapid healing; this may sometimes necessitate filling or covering deep cavities.

- (5) Watch the work from year to year for defects, and if any appear attend to them immediately.

SOME THINGS TO BE AVOIDED.

The careless use of a long pruning hook or other implement to break off small dead twigs should be avoided, as every bruise may become the point of entrance of disease or decay. Climbing spurs produce wounds that are very easily and frequently infected. Spurs should never be used except on a tree that is to be removed or destroyed. A man who insists on using climbing spurs in tree-surgery work should never be allowed to work on trees. Nails and

leather soles and heels on shoes often cause injury. Rubber-soled tennis shoes, or "sneaks," or some similar soft-soled shoe that will not slip should be used in tree-surgery work.

SURGERY WORK.

The simplest type of tree-surgery work consists in removing dead or dying limbs or neglected or decayed stubs and in treating the wounds with anti-septic and waterproof coverings, to prevent the entrance of decay-producing organisms and moisture while healing. A more complicated type consists in digging out the decayed and diseased wood of decayed spots and treating the freshly cut surfaces of the cavities with anti-septic and waterproof coatings

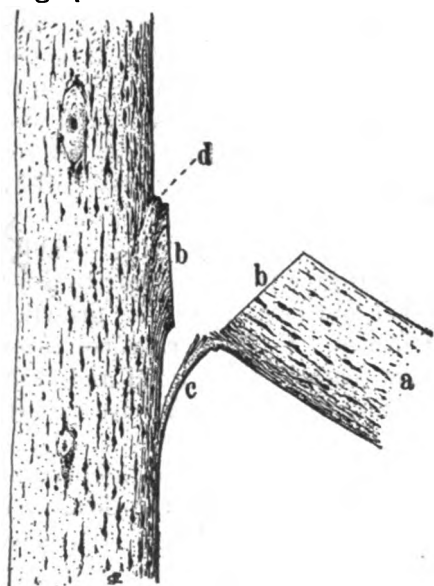


FIG. 2.—The wrong way to remove a heavy limb. A single cut from the upper side usually makes a long wound below the scar where the bark and outer wood are stripped: a, Limb; b, saw cut that severed the limb; c, strip of bark and wood stripped from the trunk; d, shoulder of the limb.

and also in filling the cavities with suitable material. Artificially filled cavities do not increase the strength of the trunk or limb to the extent that is commonly supposed. An improperly filled cavity is always a greater menace to a tree than an unfilled one.

REMOVING BRANCHES.

This work includes the removal of healthy, broken, dead, or diseased branches when the cut is made entirely through healthy wood.² This type of work can be regarded as comprising two essential operations: (1) Removing the branches in a manner that will prevent

² If decay runs back into the trunk, it will be necessary to excavate all decayed matter, following the directions given under "Cavity work."

injury to the surrounding bark and cambium and (2) shellacking, sterilizing, and waterproofing the scars.

The most essential implements for removing large branches are a good-sized saw with teeth so set as to make a wide cut, a gouge, a chisel, a mallet, a strong sharp knife, and an oilstone. For cutting limbs near the ground, these are the only necessary implements, though others often may be convenient.

For work higher up in the tree one or more ladders may be needed; also ropes. If the work is to be done from the ladder, the top of it should be securely tied or otherwise fastened to the tree

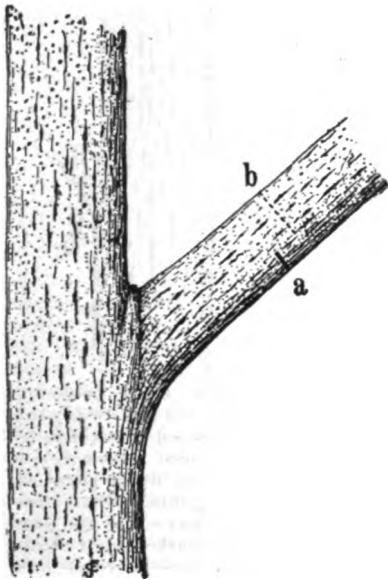


FIG. 3.—The right way to remove a heavy limb. The first cut is made on the under side of the limb, at *a*. The second cut is made at *b*, this cut being continued until the limb falls.

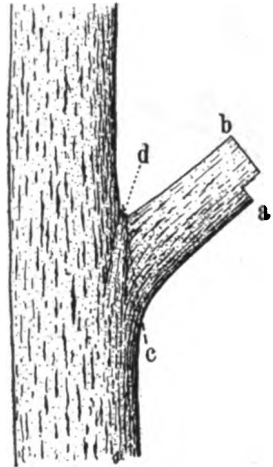


FIG. 4.—The right way to remove a heavy limb. The third cut is made close to the trunk so as to leave no projecting stub. Both *a* and *b* are the same as in figure 3; *c* indicates the position of the third cut; the shoulder of the limb is shown at *d*.

so it can not slip. Some tree workers have practically abandoned the use of ladders except perhaps to get up to the lowest branch of the tree, ropes being thrown over limbs higher up both for assistance in climbing and for support for the workmen below. A light single-pole scaling ladder similar to that used by firemen will sometimes be handier than the ordinary heavy two-pole ladder. This can be hooked over limbs at different heights and used to facilitate fastening the ropes. If a scaling ladder is used, the hook should be copiously padded with some soft material to prevent it bruising the bark. If the workman wears a heavy belt, similar to that used by electric linemen when working on a high pole, and has the lower end of the rope securely attached to the belt, a serious fall is usually prevented.

After a severe ice or wind storm all hanging branches that are a menace to life or property should be removed promptly, generally by cutting at the break. This preliminary first-aid treatment should be followed as soon as possible by the removal of the stubs in the manner described later. If the tree is badly smashed by the storm, some or all of the main stubs (after the splintered ends are cut off) may be left until growth starts sufficiently to show where vigorous buds or shoots will develop. If necessary, the ends of the stubs may then be removed with a slanting cut of about 45° just above a

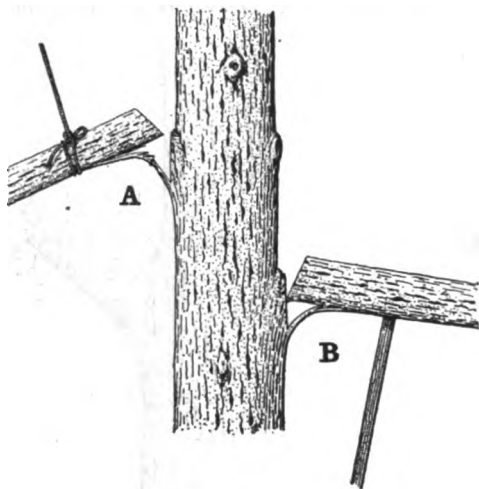


FIG. 5.—A heavy limb can often be removed safely with a single downward saw cut by supporting the limb with a tightly drawn rope, as shown at A, or by a firmly placed heavy prop, as shown at B. Both rope and prop should, if possible, be so slanted as to cause the limb to swing away from the trunk as it is severed. If the rope is tied to a living overhead branch, the latter should be well padded to prevent injury.

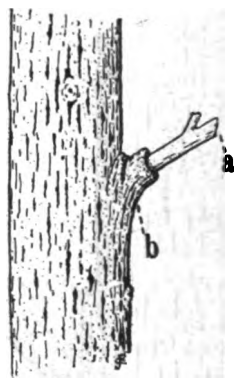


FIG. 6.—A projecting stub of decaying wood which has become a menace to the living parts adjoining. This limb was cut at the point marked a; it should have been cut at b.

vigorous bud or shoot and the scar waterproofed. The developing bud or shoot must be at the peak of the slanting cut.

A large limb rarely should be removed by a single saw cut from the upper side, as this usually strips the bark and wood below the scar as it falls (Fig. 2), unless handled as described later. A preliminary cut should be made on the under side, usually from 6 inches to a foot beyond the point where the final cut is to be made. It should reach from a quarter to half way through the limb (Fig. 3, a). A good time to stop cutting is when the saw becomes pinched in the cut. A second cut should be made on the upper side of the limb, an inch or more beyond the first one (Fig. 3, b) and continued until the limb falls. A third cut, to remove the stub, should then be made

close to the trunk (Fig. 4, *c*). When nearly severed the stub must be supported so as to avoid any possibility of stripping the bark on the trunk as it falls. The first and second cuts may be omitted when a limb is so small that it can be held firmly in place until completely severed. If desired, the edges of the scar may be smoothed with a sharp chisel to conform to the trunk. All final cuts should be made so as to allow rain water to run off readily. For this reason a limb that is vertical or nearly so should be removed with a final slanting cut.



FIG. 7.—If the shoulder has been removed and the upper and lower ends of the scar are broadly rounded or square they should be pointed, as indicated by the broken lines. If the shoulder (see Figs. 2, *d* and 4, *d*) has not been removed the pointing of the scar is not so important, and at times it is unnecessary.

A large limb often can be removed safely with a single downward saw cut close to the trunk if handled as shown in Figure 5. It is bad practice, as well as a menace to the tree, to leave a projecting stub (Fig. 6). The scar should be pointed at both ends (Fig. 7), as this is the most favorable shape for satisfactory healing.

A coat of good shellac should be applied with a suitable brush over the entire cut edge of the bark, the adjoining outer sapwood, and the cambium, immediately after the cut is made, or at least as soon as the cut surfaces are sufficiently dry. This is to prevent any appreciable drying out and consequent dying back of the cambium. If the cut has not been made through perfectly healthy wood, the wound should be cut back until sound healthy wood is reached. Usually it is unnecessary to shellac more than half an inch on either side of the cambium. If the scar is a large one, a sharp knife or drawshave should be used along the margin for one or two minutes, and then the freshly cut surfaces shellacked, repeating the operation until all the bark and outer sapwood encircling the scar have been shellacked. The maximum benefit from shellacking is not likely to be realized if the freshly cut surface is allowed to remain dry and without shellac for more than 3 or 4 minutes.*

For the work of removing small branches either a saw, a sharp strong knife, a hand pruner, a chisel, or a long pruning hook may be used, as seems most suitable. In removing small branches and twigs the cut should be made as close to the surface of the supporting branch as possible, so as to leave no projecting stub (see Fig. 6). A

*The shellac brush can be cleaned readily at any time by working it around for a few minutes in a can of water in which a little borax has been dissolved. It is then rinsed in clear water and dried before being used again. The shellac can be conserved while in use by having the handle of the brush fitted tightly through a hole in the cover of a friction-top can, the cover not being removed from the brush when the latter is used to spread the shellac.

sharp knife is the best tool for the work and should be used, when possible, in preference to the hand pruner or pruning hook. When the hand pruner is used the cutting blade should always be turned toward the tree, so that the supporting bar makes its bruise on the part that is cut away. The long pruning hook should be used with caution and only when the place to be pruned can not be reached with the knife or hand pruner. For protection against possible infection, the pruning wounds must be sterilized and waterproofed in some such manner as that recommended for larger branches. For very small wounds shellac may be as handy to use as any preparation. Liquid grafting wax or shellac is particularly satisfactory for scars less than a half inch in width on choice trees or shrubs or on those that are susceptible to injury from the use of tar or creosote.

The statement has often been made, and very widely accepted, that it is not necessary to paint the scars made by cutting small branches, a half inch or less in diameter; but the writer has observed many instances where serious diseases have gained entrance through wounds that were considerably less than half an inch across. For thorough and careful work, particularly on choice trees or shrubs, the smaller scars should be as thoroughly treated as the larger ones.⁴ Care should be taken, however, that the waterproof covering is not applied to the surface of the uninjured bark adjoining the wound, as this may cause injury through partial asphyxiation.

STERILIZING AND WATERPROOFING THE WOUNDS.

Many antiseptic and sterilizing preparations have been used with more or less success. Ordinary commercial creosote (a coal-tar product, sometimes called creosote oil) apparently is one of the best preparations for destroying and preventing the growth of certain wood-destroying fungi. It can be applied with an ordinary paint-brush and should cover every part of the exposed wood which has not already been covered by the shellac. The entire shellacked and creosoted surface should finally be waterproofed with thick coal tar or asphalt.⁵ A single application of a mixture of creosote and coal tar (about one-fourth or one-third creosote) to cover the entire scar has been quite extensively used with good results. A better mixture is made by melting asphaltum and mixing with it an equal quantity (by weight) of creosote.⁶ If too thick to apply when

⁴ Small scars near the tips of small branches are not usually a source of great danger, for if infection takes place it usually is possible to cut off the small limb farther back without seriously disfiguring the tree.

⁵ For applying hot asphalt use a cloth swab or a brush made of broom corn, as the bristles of an ordinary brush are usually quickly destroyed by the hot asphalt.

⁶ It usually is necessary to set the kettle or pail containing this mixture in a larger kettle of boiling water for an hour or more, in order to completely dissolve the asphalt. As creosote is inflammable, care should be taken that it does not come in contact with the flame, as might happen if the heating were done directly over an open fire.

cold, add more creosote and stir. Asphalt, without creosote, is an excellent waterproof covering and doubtless would be more generally used were it not necessary to apply it hot. Paint frequently is used for waterproofing but is less permanent.

Creosote and tar at times will cause slight injury when used around wounds on certain trees, especially cherries, peaches, and plums. Except on magnolias and tulips such injury has not been especially noticeable on most of our common shade trees. If injury from the use of creosote and tar is feared or suspected, a moderately blue solution of copper sulphate in water⁷ or 1 part of corrosive sublimate in 1,000 parts of water⁸ may be used as an antiseptic wash. As soon as this is dry the wound can be painted with any good lead paint, or even varnish.

Grafting wax (particularly thick liquid alcoholic grafting wax) is excellent for waterproofing small surfaces.

Another good method of treating the scars is to char the surface with a gasoline or alcohol blast torch and then quickly cover the hot surface with heavy tar, pitch, or hot asphalt. Heat is an excellent sterilizing agent, but it kills back the cambium considerably.

On particularly choice trees, where the black color of tar or asphalt is objectionable, the scar can be sterilized with the corrosive-sublimate or copper sulphate solution and as soon as dry shellacked. After a week or two the shellacked surface should be painted with spar varnish. For many purposes and on many trees this treatment is particularly satisfactory. If the scar is clean and healthy and not located near any former area of decay or disease, the sterilizing washes may be omitted and the shellac applied directly to the unsterilized scar. The alcohol in the shellac is a good sterilizing agent. If it is desirable that the scar be colored to match the bark, a suitably colored coat of paint can be applied over the shellac and allowed to dry before the coat of spar varnish is applied, or the spar varnish may be omitted.

Permanently good results from waterproofing can be assured only when the treated surfaces are watched from year to year and re-

⁷ 1 pound of copper sulphate in 3 or 4 gallons of water.

⁸ Corrosive sublimate (or bichlorid of mercury) is a deadly poison to man or animals if taken internally and is a caustic or corrosive agent on the skin or on metals. The 1 to 1,000 solution can be made most readily by purchasing the 7 or 7.3 grain tablets of bichlorid of mercury at a drug store, where they are sold subject to laws governing the sale of poisons. One of these tablets dissolved in a pint of water will make a solution of the proper strength. The solution should be freshly mixed for the best results. Usually it will retain sufficient strength for ordinary use for two or three months. If placed in an amber or blue bottle away from the light, it will keep at least two or three times longer. As a precautionary measure against the accidental poisoning of domestic animals, the discarded solution should be buried rather than poured into a sink drain or thrown out on the surface of the ground. Solutions should not be kept in metal containers, nor should brushes with metal coverings or wire-fastened bristles be used for applying it, as the solution promptly corrodes all metal with which it comes in contact.

coated annually or biennially, especially when any tendency of the coating to crack or peel is observed. This is an important part of the work, a part which is commonly neglected. It is best to recoat the wounds regularly every year or two, even though no cracks appear.

The healing of wounds by means of new callus growth at the sides is often more rapid if neither paint nor other generally used waterproof covering is applied (shellac excepted). However, the rapid healing of the wound is of secondary importance to that of preventing the entrance of decay-producing organisms. To prevent decay is one of the most important and essential considerations in tree surgery. It is of vital importance in the care of long-lived trees. With short-lived trees it obviously is of less relative importance.

One of the best (though little used) methods of counteracting the danger arising from cracks in large flat scars, particularly scars that are sound and healthy, is to cover the freshly waterproofed wood of the wound with sheet metal, heavy tarred paper, or heavy cloth, firmly tacked down and waterproofed.⁹

CAVITY WORK.

When an injury or wound has been allowed to remain untreated for a year or more, decay-producing organisms are almost certain to have produced an area of decay behind the exposed surface of the wood. If untreated, this area increases in size and depth as time passes until it so weakens the limb or tree that a storm may break it at the weak point, or the decay may have developed to such an extent that any attempt at treatment would be a waste of time and money. Such areas of decay often are aggravated and increased by the presence of insects, particularly borers and ants. All such regions of infection or decay must be attended to promptly if the best possible results are to be realized. Whatever may be the size of the decayed or diseased area or wherever it may be located, the first steps toward checking its progress are practically identical in all cases. They may be regarded as comprising two essential operations: (1) Excavating all decayed and diseased wood and (2) sterilizing and waterproofing all cut surfaces.

The necessary tools for digging out the decayed wood are few. As a rule, two outside-ground socket-handled gouges, a chisel, a mallet, a knife, and an oilstone are sufficient for ordinary work. One gouge should have a curved cutting edge of about three-fourths of an inch and the other perhaps $1\frac{1}{2}$ inches. A smaller and stouter gouge may have to be used in cavities in trees that have very hard wood, e. g., live oaks, etc. The gouges, chisel, and knife should

⁹ For a detailed account of this method, see the Weekly News Letter of the United States Department of Agriculture for Feb. 9, 1916.

never be used on the bark or near the cambium when they lack a keen edge, as dull tools will injure the latter. In cutting out deep cavities, longer interchangeable handles for the gouges may be necessary. A ladder or a stepladder may be required if the work is more than 5 or 6 feet from the ground. As the work progresses, the desirability or convenience of having certain other implements will often become evident.

EXCAVATING.

Usually an old neglected area of decay may be partially or wholly covered at the surface by a comparatively recent growth of wood and bark around the edges, and the visible decay may be small as compared with the part which is hidden (Fig. 8). Indeed, this is the usual condition. In such cases it often is necessary to enlarge the opening in order to have sufficient room in which to gouge out the interior. This opening should not be made any wider than is necessary, but it may be sufficiently long to reach all the decayed and diseased heartwood with little or no additional injury. The opening should be pointed at both ends. If much living sapwood is cut away at the sides of an opening during the growing season the foliage of the tree should be reduced by pruning or stripping sufficiently to prevent wilting.

The most important part of this work is to remove every particle of diseased or insect-eaten wood. This excavating must continue everywhere until sound and uninfected wood is reached. All discolored or water-soaked wood should be removed, as this is the region in which the rot-producing fungi are usually most active. Infected wood usually extends some distance above and below the visibly discolored portion. In decayed areas of many years' standing there may be only a thin shell of healthy wood around the cavity, in which case there is danger of the tree being broken by storms unless braced or guyed, as mentioned later (pp. 27-29). Unless there is some very special reason for attempting to prolong the life of such a tree it is better to have it removed and replaced by a healthy one. If desired, a comparatively large tree can be moved in to replace it. In experienced hands the transplanting of large trees can now be done with reasonable assurance of success.

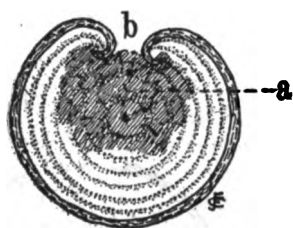


FIG. 8.—Section of a tree with an old wound partially healed over, showing a large decayed area (a) with only a small opening (b) visible from the exterior. In excavating the decayed area the cavity should reach back in all directions into sound wood.

SHAPING THE CAVITY.

Whenever possible, the bottom and all other parts of the cavity should be shaped so that water thrown into the cavity will run out promptly and none remain in any hollow. When the cavity extends below the surface of the ground (rarely at other times), it is not possible to drain it in the manner mentioned. Under such conditions the lower part of the cavity should be filled to a few inches above the level of the ground and the top of the filling sloped so as to throw the water out of the cavity in case the whole cavity is not to be filled.¹⁰

It is bad practice to have a deep water pocket at the bottom of a cavity with drainage provided through an auger hole bored from the

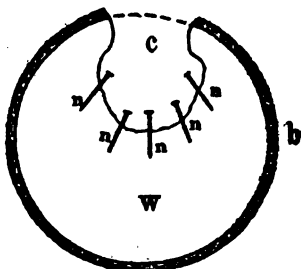


FIG. 9.—Section of a tree cavity, showing how it is undercut at the margins to assist in holding a plastic filling in place; it also shows nails driven into the back of the cavity for a similar purpose: *b*, Bark; *c*, cavity; *n*, nails; *w*, wood.

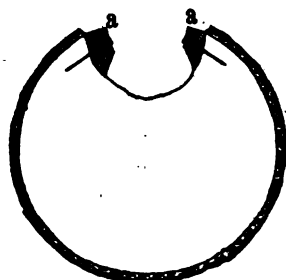


FIG. 10.—Section of a tree cavity, showing how strips of wood (*a*) can be nailed along the edges to prevent the inrolling of the new callus growth and at the same time to hold a plastic filling more firmly in place. In open cavities the back edge of the strip should be beveled, as indicated, so as to allow ready inspection of all parts of the cavity; in cavities to be filled the back edge should not be beveled.

exterior. An open hole of this sort usually becomes a favorable lodging place for insects, fungous spores, yeasts, and bacteria, any one of which may cause trouble.

As already emphasized, great care must be taken in working around the cambium, and all cutting tools must be kept very sharp. The final cutting along the edges of the bark and sapwood can often best be made with a very sharp knife or drawshave. This cutting must be followed immediately by a coating of shellac, which should cover the cambium and a narrow strip of the bark and adjoining sapwood (see p. 9).

¹⁰Asphalt and sawdust (or sand) make one of the best mixtures to use in such places (see pp. 21-24).

UNDERCUTTING.

A point to be borne in mind in shaping a cavity that is to be filled with cement is to have the sides undercut if possible (Fig. 9), so as to hold the filling more firmly in place. Care must be taken, however, that the living wood at the edges of the opening is not very thin, as this promotes the drying out of the sapwood and bark at these points. Ordinarily the edges should be at least three-fourths of an inch thick ($1\frac{1}{2}$ inches is better). When possible it should include the full thickness of the sapwood. Inrolled bark at the edges of an opening should be cut away. If it is not possible to undercut sufficiently to hold a cement filling firmly in place, the alternative method described under "Nailing or stapling" can be adopted, or one or more strips of wood can be nailed around the cavity, the outer surfaces of which are level with the cambium (Fig. 10).

STERILIZING THE CAVITY.

After the decayed and diseased matter has been completely excavated and the edges of the sapwood and bark adjoining the cambium shellacked, the remainder of the cavity also must be sterilized. As already stated (pp. 10-11), cresote appears to be one of the best generally known preparations to use. Every exposed part of the wood and bark must be sterilized, and over this and the shellacked portion a heavy coating of tar, hot asphalt, or some other suitable waterproof covering applied.

This completes all the essential operations in cavity work. Filling a cavity is of much less importance and in many cases entirely unnecessary. Oftentimes a cavity is safer and better if left unfilled; it certainly is if cement is used in a long, large, or shallow cavity, or in small cavities if the work is done carelessly or ignorantly.

OPEN CAVITIES.

A tree cavity which has been excavated, sterilized, and waterproofed in the manner just described is in condition to be left, with occasional inspection, in comparative safety for years. Cavities treated in this way probably are safer than most covered or cement-filled cavities, and, furthermore, they have the advantage of permitting easy inspection from time to time. The new growth of wood and bark along the margins will gradually form an inwardly rolled edge if there is no filling, sheet metal, or artificial ledge (see Fig. 10) to force it across the cavity. Practically all shallow cavities should be left open, for, with few exceptions, there is no safer, simpler, or more satisfactory method of handling them.

An open cavity must be watched from year to year, and any tendency of the waterproof coating to crack, peel, or blister should imme-

diately be counteracted by repainting. This is an important point, which must not be neglected. It is better and safer to repaint every year (or at least every two years) until healed over, without waiting for defects to appear.

COVERED CAVITIES.

Sheet tin, zinc, copper, iron, and other metals and materials have been used to cover cavities. When properly applied, these coverings assist in keeping out disease, decay, and insects for a long time and in forcing the new growth across the opening. If improperly covered or if the cavity itself is not properly treated, such a metal-covered cavity is a greater menace to a tree than an open one. In preparing a cavity for a sheet-metal covering, all the decayed, diseased, and insect-eaten wood should be removed in the manner al-

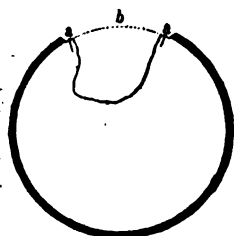


FIG. 11.—Section of a tree cavity, showing the marginal ledge of wood (a) to which a sheet of metal (b) can be tacked to cover the cavity.

ready explained, with two modifications: (1) There is no necessity of undercutting the cavity and (2) there should be a narrow half-inch ledge of wood around the edge of the cavity from which the bark has been removed and to which the margin of the sheet metal can be tacked (Fig. 11). The cavity must be thoroughly sterilized and waterproofed, as already described. The sheet metal should be trimmed so as to fit the opening but leave a strip of bare wood one-sixteenth to one-eighth of an inch wide between the edge of the metal and the edge of the bark. This can best be done by first

trimming a heavy-paper pattern to fit the opening. The metal should be cut the same shape as the paper pattern and then placed on a block of wood and holes a half inch or an inch apart punched or drilled along its margin, through which slender flat-headed brads or nails may be driven into the ledge of wood around the cavity. The edges of the cavity and the inner side of the metal should be freshly waterproofed (the entire cavity already having been so treated). The metal should be put in place and nailed with a light hammer, allowing it to curve outward so as to conform to the general shape of the trunk or to curve inward. Two or more pieces of sheet metal with overlapping joints should never be used unless these joints are soldered air-tight. If all insect tunnels have not been cut out, the cavity should be fumigated by saturating a wad of cotton or cotton waste with carbon disulphid¹¹ and suspending it with a string in the top of the

¹¹ Carbon disulphid should not be used near a fire or an open light, as under such circumstances it is explosive. See Farmers' Bulletin 799, entitled "Carbon Disulphid as an Insecticide."

cavity for 12 hours or more before the metal is permanently nailed to the wood at the top. During the fumigating process the cavity must be tightly closed and sealed. The final operation is to waterproof the outer surface of the metal, the cut edges of the bark, and the strip of wood between them, taking special care that the tacked edges of the metal are made as air-tight and waterproof as possible. During all parts of the operation care should be taken that the cambium is not bruised or unnecessarily cut.

BOLTED CAVITIES.

If a long cavity is to be filled with cement it usually is advisable to place through it one or more bolts to hold the wood more firmly

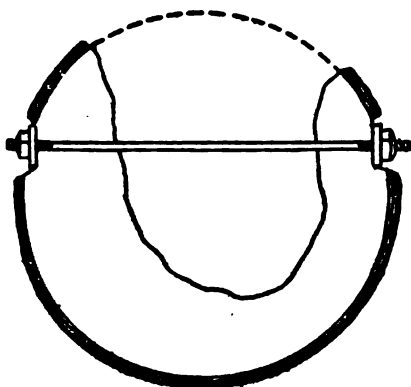


FIG. 12.—Section of a large tree cavity, showing how a single bolt should be placed to hold the sides rigid.

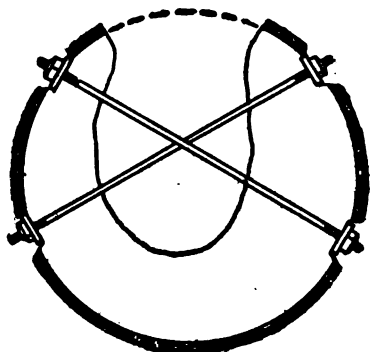


FIG. 13.—Section of a large tree cavity, showing how two bolts should be placed to hold the sides rigid.

against the filling. A cavity 2 feet or less in length will not usually require a bolt, but long cavities as a general rule should be bolted every 18 to 24 inches. Oftentimes a single bolt can be placed so as to support both sides (Fig. 12). In certain cavities it may be necessary to place bolts at different angles (Fig. 13). In any case a strip of uninjured bark and cambium at least an inch wide should be left between the edge of the cavity and the end of the bolt. On medium-sized trunks, after deciding where the bolts can most efficiently be placed, a sharp bit, a half-inch (or larger) in size and sufficiently long to reach through the trunk and cavity, can be used to bore the hole for the bolt. On large trunks a larger bit should always be used. Iron or steel washers (preferably oval) about three times the diameter of the bolt (Fig. 14) should be countersunk into the wood by carefully cutting away the bark and wood at both ends of the hole. The washers should be heavy and ample, but not so broad as to necessitate cutting away an excessively large piece of bark. In most trees when

round washers are used it is advisable to have the bark adjoining this countersunk area somewhat pointed above and below the washer (Fig. 15), for reasons already mentioned. By holding the two washers in place, the length of the iron or steel machine bolt needed can be determined by measuring through the hole. The bolt must be thick enough to fit snugly in the hole and should project beyond each washer for at least one-fourth inch. The thread at each end of the bolt must be coarse and sufficiently long to permit drawing in the sides of the cavity as the nuts are screwed up firmly against the washers. A chamfered single-headed bolt may be used, if preferred. Before the bolts are finally put in place the countersunk cuts and the bolt holes should be tarred or creosoted, and after the bolts are in place all exposed parts of the bolts and nuts should be waterproofed.

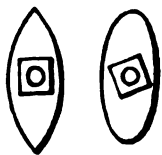


FIG. 14.—The ends of two bolts with oval washers. The long diameter of the washers should run lengthwise of the trunk or limb.



FIG. 15.—The end of a bolt with a round washer. Triangular pieces of bark should be cut away above and below the washer, as indicated by the broken lines.

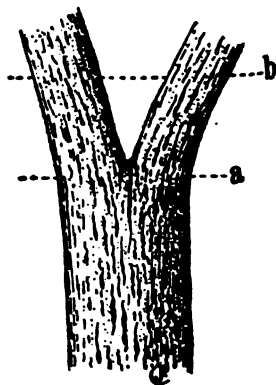


FIG. 16.—A split crotch; the dotted lines *a* and *b* indicate the position in which bolts should be placed to hold the split.

If the washers and nuts are sunk deeply into the wood the holes at the ends of the bolts may be filled with cement or asphalt to the level of the cambium. This will make a neater looking job and leave the spot in better condition for healing.

All split cavities must be securely bolted, particularly near the upper part. If the split comes from a crotch, all decayed and diseased wood should be removed from the split and an antiseptic wash and waterproof coating applied, after which it can be bolted just beneath the crotch (Fig. 16. *a*) so as to close the crack or at least bring the parts back to their normal position in case decayed matter has been excavated from the crack. If the split is a recent one, an antiseptic wash alone usually will be sufficient before drawing the sides together with bolts.

Under most conditions, particularly in large trees, it will be necessary to use a rope and tackle blocks some distance above the crotch

to pull the limbs together so as to properly close the crack before bolting it. When tackle blocks are used care must be taken to have an abundance of bagging or other padding between the bark and the encircling ropes, or, better, a short piece of heavy woven or leather belting a few feet in length, with a heavy metal loop at each end for attaching to the tackle blocks, can be used. Finally, all exposed edges of the crack must be thoroughly waterproofed. If necessary, limbs above split crotches may be guyed, as described later. If there is a cavity in the crotch, it should be cleaned and the limbs above it firmly guyed before the cavity is filled.

FILLING CAVITIES WITH CEMENT MIXTURES.

If desired, cavities made by excavating decayed material may be filled with any one of a variety of substances. The most important purpose of the filling is to prevent the new growth of wood and bark from curving or rolling into the cavity, and not to strengthen the trunk, as many people suppose. At present the most widely used material for this purpose is cement, usually in the form of cement mortar or concrete. There are many theoretical and practical reasons why the use of cement should be discouraged. The use of cement in long or large cavities, either in one solid piece or in sections, should be avoided. Under ordinary conditions such cavities had better be left open or perhaps filled with asphalt or wood, or both. However, cement appears to hold fairly well in small or globular cavities in the trunk and larger limbs that are not easily bent by a high wind.

If for any reason it becomes necessary or desirable to fill a long or large cavity with cement, the method of preparing the cavity is the same as already described (p. 13); in addition the cavity may be fitted with rods, bolts, or wires for reinforcing the cement. There are various ways of doing this, the choice of methods depending largely upon the location, size, and shape of the cavity. One simple method is to drive heavy staples along the sides of the cavity, from 4 to 8 inches apart and 3 or 4 inches back from the cambium. Between these staples heavy wires are stretched across the cavity, criss-cross or straight. Another simple method is to use a few iron rods, the ends of which are set into holes bored in the wood. Straight rods can be bent in order to insert the ends in the holes and then straightened, or one end of the rod can be bent at a right angle and the long end inserted in a hole at the top or bottom of the cavity and the short end in a properly located hole at the back or side of the cavity. One rod or several such rods may be used, as seems desirable. At other times it may be preferable to place a few bolts through the cavity. Bolts hold the sides of the cavity more firmly against the

hardened cement. The bolts should be placed in accordance with the instructions given on pages 17 to 19.

Nailing or stapling.—In a cavity with a comparatively large opening or with little or no undercutting it is common to drive flat-headed wire nails or large staples for half their length into the wood in the interior before inserting the cement. In medium-sized cavities large staples or nails 2 or 3 inches long may be driven into the wood for about half their length (Fig. 9). The loops of the staples or the heads of the nails finally are completely embedded in the hardened cement, thus preventing the filling from falling out of shallow cavities under ordinary strain.

Mixing the cement.—A good grade of Portland cement and clean sharp sand free from loam (1 part of cement to 3 or less of sand) should be used. The mixing can be done in a mortar bin, a wheelbarrow, a pail, or in any other available receptacle that is sufficiently large. A quantity of dry cement and sand sufficient to fill the cavity should be thoroughly mixed before adding water to make a very stiff mortar and the whole mixture worked to an even and smooth, but not watery, consistency.

Filling the cavity.—For placing the mixture in the cavity a mason's flat trowel and an ordinary garden trowel with a concave blade will be found convenient. A tamping stick 1 or 2 inches thick and 1 to 3 feet long, depending on the size of the cavity, may be needed. A layer of cement 2 or 3 inches deep can now be placed in the bottom of the cavity with the trowel and tamped firmly in place. This operation is repeated until the cavity is filled, the tamping being directed mainly toward the back of the cavity rather than downward. If the mixture tends to run out at the bottom of the cavity under the operation of tamping, it is too moist. If the mixture remains somewhat granular or powdery and does not pack down promptly, too little water has been used. The remedies for such wrong mixtures are obvious. When the cement has partially set, the outer surface should be carefully smoothed or cut down with the flat trowel to the level of the cambium, as shown by the dotted lines in Figures 9, 12, and 13, taking great care that the latter is not injured in the operation. If the cement is allowed to set too firmly to trim with the trowel, it can still, with more or less difficulty, be cut back to the cambium line with a cold chisel and hammer.

Thin mixtures of cement will set more firmly. If a mixture thinner than the one indicated above is used to fill a cavity, some sort of cloth or wire dam will have to be used to hold the cement in place until it is set. It may be convenient to use such a dam on all except cavities with small openings. One simple method is to wrap strips of burlap around the tree so as to cover the lower part of the open-

ing, if the mixture is not very thin; otherwise, a more closely woven fabric, such as canvas or carpet, may be used. This dam at first should cover only the lower part of the opening, and should be loose enough to allow it to be pushed outward to about the normal contour of the trunk when the cement is tamped in place behind it. The cavity is filled with cement to the top of the dam and the height of the dam increased as becomes necessary by wrapping more cloth or wire about the tree without disturbing that already in position. After the cement has partially set but before it has become hard, the dam is removed and the surface of the cement trimmed back with the mason's trowel and finished in the usual manner. At times it is advisable to have a dam of wire netting of a quarter or half inch mesh nailed to the wood at the sides of the cavity a quarter or half inch back of the cambium, to reinforce the filling and hold it in place. This wire netting remains permanently embedded in the cement.

The edges of cement fillings in crotches are especially difficult to keep water-tight. Besides bolting the cavity and guying the limbs above it, the edges of such cement fillings must be made as near absolutely waterproof as thick tar, asphalt, or some good elastic cement, preferably with an asphalt base, can make them. A mixture of asphalt and sawdust is much better than cement to use as a filler in such locations.

After a cement filling has become dry, the outer face may be covered with coal tar or paint. If cracks appear in the cement or the wood draws away from the cement, both of which commonly happen, or the work is not properly done, decay-producing organisms frequently gain entrance at the edge of the cement and cause serious trouble.

FILLING CAVITIES WITH ASPHALTUM MIXTURES.

For covering large wounds or for waterproofing cavities, asphaltum (commonly called asphalt) apparently is not equaled by any other substance that has been mentioned in this bulletin. The asphaltum referred to is a product of the distillation of some of the western petroleums and varies in melting point from the boiling point of water upwards. The greatest objection to its use is the fact that it has to be kept melted and used while hot. This makes the process cumbersome and inconvenient, which in itself is a serious objection from many points of view, although a coating of asphalt, properly applied at the outset, will often last for years without special attention. For normal scars it should be used clear and applied with a swab or small whisk broom.

As an efficient cavity filler asphalt has few of the objections found in cement, because its elasticity and resilience prevent cracking, and it is absolutely waterproof. It is very adhesive and does not readily

separate from the wood when properly applied. For filling a cavity it should not be used clear but in combination with coarse, dry sawdust, excelsior, shavings, sand, asbestos, or some other substance.

An outline of two methods of using a mixture of asphalt and sawdust to fill a cavity will serve in general for the other mixtures mentioned. The first method will be most useful when a fire or stove can be used near the tree, and the second where this is impracticable, as, for example, on a well-kept lawn or near shrubbery that might be scorched by the heat.

First method.—Thoroughly melt the asphalt in a kettle or other suitable receptacle and slowly stir in the coarse, dry sawdust. Continue adding the sawdust as long as the particles are blackened by the asphalt after a few moments' stirring. This hot pasty granular mixture can then be placed in the cavity, which has been prepared as already described, and pressed or tamped into close contact with the side of the cavity before it hardens or cools. For placing the mixture in the cavity, which already has been waterproofed with clear hot asphalt, a trowel, paddle, or ladle can be used. The tamping stick should have a smooth and slightly rounded end. The end may be covered with sheet metal if desired, or a tamping rod made of iron may be used. If the mixture adheres to the end of the tamping stick to an extent that interferes with the work, a quick twist as it is about to be withdrawn will usually improve conditions. It may be necessary to grease or wet the end of the stick frequently. Often the best results are realized when a steady slow pressure is exerted rather than a quick tamping movement. A very excellent 2-foot tamping stick can be made from a shovel handle. The grip at the end gives a ready purchase for the twisting motion. The opposite end of the stick should be rounded, sandpapered, and soaked in a lubricating oil or in hot tallow for some hours before using.

Second method.—Mix the asphalt and sawdust in a kettle, as described under "First method," over any suitable stove or fire and at any place where it may be most convenient. When thoroughly mixed, dip it out of the kettle and place it on sheet metal to cool in the form of pancake-shaped or biscuit-shaped lumps, whichever form may be the most conveniently used or handled. The sheet metal may be greased or not. The asphalt mixture can be removed when cold by applying a blast torch to the back of the sheet metal if necessary. Another and often more convenient way of preparing the lumps is to drop the hot mixture into shallow molds made in the ground or in sand, and brush off the dirt or sand when the lumps are cold. These lumps of asphalt and sawdust can then be transported wherever they are to be used, or they can be stored indefinitely for future use. When filling a cavity they may be used whole or broken into pieces. A blast torch may be used to soften the surface of the lump before it is pressed into place in the cavity and nailed firmly to the wood, or the lump may have nails driven into it and then partially or completely dipped into melted asphalt and immediately nailed into the cavity. All the lumps should be nailed firmly in place. Small sheets of wire netting, burlap, or canvas often can be nailed or stapled over different layers of the asphalt mixtures with good results; preferably so they will not show on the surface when finished. This operation, perhaps with slight modifications, is repeated until the whole cavity is filled. When the blast torch is used in the interior of the cavity care should be taken that the cambium is not overheated.¹²

¹² One simple way of preventing this overheating is to have a broad flexible paddle of wood, fiber, or other nonconductor of heat that can be held over the cambium and bark with one hand while the torch is being used with the other. After a little practice the torch will rarely have to be used inside the cavity.

After all the decayed matter has been removed and the cavity sterilized and waterproofed, there is no immediate danger in delaying subsequent operations if for any reason such delay seems necessary or desirable. Moreover, it is unnecessary to put all the filling compound into the cavity the same day, or the same week, or even the same month. After asphalt mixtures have cooled, the hot sticky surface can be restored by passing a hot iron over it or by protecting the cambium and using a blast torch. This melting of the surface should be done just before another batch of filling is added, especially when the first method mentioned is used.

When a cavity has been filled by either method, the surface of the filling can be finished off with a hot iron to the level of the cambium, as shown by the dotted lines in Figures 9, 12, and 13. If a sufficient quantity of sawdust has not been mixed with the asphalt or if too much clear asphalt has been used to cement the lumps together when the second method is used, the composition will slowly slump, causing it to break away from the wood at the top of the cavity. To prevent this slumping the surface of the finished filling may be covered with canvas, closely woven burlap, thin strips of wood, wire netting, or other suitable covering, and held in place with long nails, screw bolts, or staples that reach into the solid wood at the back of the filling.¹³ In shallow fillings a simple way is to drive in closely set long nails, each nail passing through a large metal washer. As a rule, if these washers are closely set no other covering is necessary. When any of these surface coverings are used the outer face should be no higher than the level of the cambium and finally should be waterproofed with tar, asphalt, or paint.

Care should be taken to avoid bruising or unnecessarily heating the cambium at any time. A very good tool with which to finish the raw surface near the cambium is a small mason's trowel, the tip of which can be heated for a few seconds at a time in the flame of a blast torch. A tool of this general shape with a thin edge but with more metal at the center is better and will hold the heat longer. For finishing farther away from the cambium, a larger and heavier tool will be more useful; an old-fashioned flatiron does this work efficiently and can be used for this purpose if nothing better is available. If masses of asphalt project too far beyond the contemplated finished surface to be smoothed readily with a hot trowel, they can be cut off with a hot trowel or with a cold chisel and hammer before the surface receives its final smoothing.

¹³ If the bolts, nails, or staples are too thick to be driven through the asphalt without cracking it, they can be heated and slowly pushed through to the wood.

In deep cavities a better method is to fill roughly with wood (see next section) to about an inch or less back of the cambium and finish with asphalt, as just described.

FILLING CAVITIES WITH WOOD.

Asphalt can be used along with chips, larger blocks, or strips of dry wood (such as laths or scantlings) for filling cavities. When blocks or strips of wood are used as the main filling substance they can be trimmed roughly to fit into various parts of the cavity or the whole cavity and nailed in place. A good way to do this is to trim a block or strip roughly to fit the desired place, then remove it from the cavity and drive the required nails or staples part way through it. At times it may be advisable to use screws or bolts instead of nails or staples.

The back of the block or strip and that portion of the cavity in which it is to be placed should be covered with a thick coat of hot asphalt or almost any of the mixtures mentioned above, except perhaps asphalt and chips, and the strip nailed in place. A long heavy nail set (or center punch or saddle punch) may be useful in driving the nails or staples into the strips. The blocks or strips of wood need not be very carefully fitted, because the asphalt mixtures, particularly asphalt and sawdust, will fill practically all spaces between them. It usually does no harm if some spaces are not filled, provided they are not at the surface of the filling. Preferably the grain of the blocks or strips should run lengthwise of the trunk and extend the entire length of the cavity, at least when near the surface. In large cavities a strip or layer of strips an inch or two thick can first be placed in the back of the cavity and then the building up done mainly from the sides (Fig. 17). If the filling is planned so that there will be an unnailed but thoroughly asphalted closely fitting joint extending the length of the cavity and from the layer of strips first nailed to the back of the cavity to its outer surface (see Fig. 17, *a-c*), there will be practically no danger of the filler pulling away from the sides of the cavity as a result of a sudden contraction of the sapwood. In such a filling the opening, if it comes, will be along the line of least resistance, which in this case will be, almost invariably, the unnailed joint lengthwise of the filling. In section this joint may be a straight or a zigzag line, preferably the latter. As the crack closes, the asphalt will usually cement the two edges of the joint together again; but even if it does not, both surfaces of the crack still will be covered with waterproof asphalt.¹⁴ If the strips of wood used in the cavity are creosoted before they are put in place, the danger

¹⁴ If the wood strips used are soft or easily split, it will be safer to use coal tar in this joint, as cold asphalt will sometimes cause the wood to split before the asphalt will yield. If the wood should split, the crack should be filled with coal tar.

of infection as a result of wetting is still further safeguarded. The exposed surface of the completed filling should be smoothed off at the level of the cambium, so as to conform more or less closely to the shape of the trunk (Fig. 17), and finally painted with hot asphalt, coal tar, or paint of any desired color.

For keeping the asphalt melted some sort of heater will be required. In most cases one that is readily portable will be most useful, for the asphalt can usually first be melted over some less portable heater or stove and the portable heater used merely to keep the asphalt melted while it is being used. Often it will be most convenient to have a rather small heater, such as some blast torch or a plumber's or tinsmith's stove; possibly one that can be suspended by a padded wire from a limb of the tree. A galvanized-iron pail with a capacity of about 10 quarts may be useful for this purpose. The bail socket should be riveted to the pail. With a little ingenuity one of the heaters mentioned above can be altered so that it may be suspended by means of two long hooks to the bail sockets of the pail or to the top of the pail and the pail and the attached heater carried about by the bail, yet the two can readily be separated if desired. The pail and heater can be suspended from the limb of a tree by a padded hook, or the heater can stand on a board on the ground and the pail be set on top of it.

Oftentimes it is neither necessary nor desirable to completely fill a cavity; or perhaps the necessary time to complete the work promptly is not available. Under such conditions the cavity can be cleaned out, sterilized, and waterproofed and then strips of waterproofed wood nailed along the edges of the cavity, the outer edge of the strip being at the cambium line (Fig. 10). In most cases if this strip is a half inch thick it will serve for some time to prevent the new callus wood and bark from rolling inward into the cavity, and before the new growth has reached across it another strip can be nailed over it, or the cavity completely filled, perhaps with asphalt and sawdust. If this method is followed it will be necessary temporarily to fill and waterproof the small pocket back of the strips at the bottom of the cavity, using wood or some plastic substance so that it will not hold water.

If it is impracticable or inconvenient to use hot asphalt and sawdust between the strips of wood in filling a cavity a substitute can

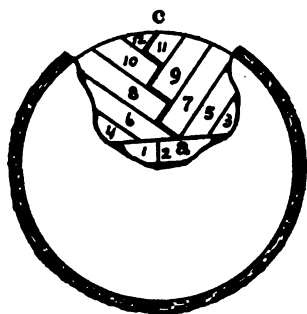


FIG. 17.—Section of a tree cavity filled with strips of wood. The numbers on the strips indicate the order in which they are inserted. No nails are driven across the zigzag line a-c.

be found by mixing sawdust with creosote and asphalt,¹⁵ or with coal tar, or even with paint. When any of these mixtures is used the strips of wood may have to be trimmed to fit more closely, as such mixtures will not so readily and permanently fill large spaces between the strips as will the thicker asphalt mixtures. Perhaps the best homemade substitute for the heavy asphalt is a mixture of coal tar and sawdust. This mixture does not necessarily have to be heated during any part of the operation unless the work is done in very cold or freezing weather. It is better, however, to have the tar hot when the sawdust is mixed with it. No definite proportion for the tar and sawdust can be recommended, because the quan-

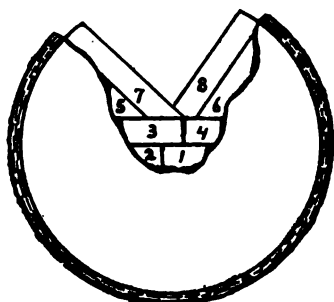


FIG. 18.—Section of a tree cavity partially filled with strips of wood. The numbers indicate the order in which the strips are inserted.

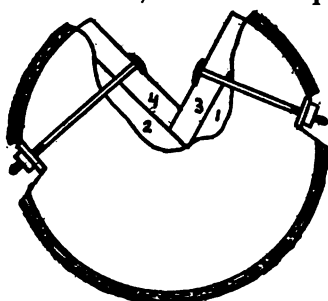


FIG. 19.—Section of a tree cavity partially filled with strips of wood; these are bolted to the walls of the cavity. The numbers indicate the order in which the strips are inserted.

tity of each ingredient is largely dependent upon the grades of sawdust and tar that are used. In his own work the writer has found that 1 part of dry sawdust by weight to 3 or 4 of coal tar or 3 to 4 parts of dry sawdust by bulk to 1 of coal tar gives a mixture of about the right proportions. The mixture should be stirred (preferably when warm) until it is of an even consistency—somewhat granular but sticky and pasty. When put in the cavity it should stick there after a little pressure or after tamping with an oiled or moistened stick, but should not be thin enough for the tar to ooze out, at least not until the mixture is compressed by nailing or stapling the wood strips firmly in place over it. It will be advisable to paint the exposed wood, the strips that have been fastened in the cavity, and the back of the strip that is to be inserted, using clear coal tar, before inserting the sawdust and tar mixture.¹⁶

Generally some such arrangement of strips as is shown in Figures 17, 18, and 19 will be found most advantageous in most cavities, as

¹⁵ For directions for mixing creosote and asphalt, see p. 10.

¹⁶ An excellent preparation to use between the strips of wood, containing asphalt and asbestos, can be readily bought on the market, and it has the advantage of being mixed ready for use.

such an arrangement usually permits entire freedom in driving the nails or staples or in placing the screws or bolts in position through the strips. The edge of the strips at the surface should be trimmed off in a line with the cambium, as shown in Figures 17 and 21, or the strips may be trimmed back to a line behind the cambium and one, two, or more thin

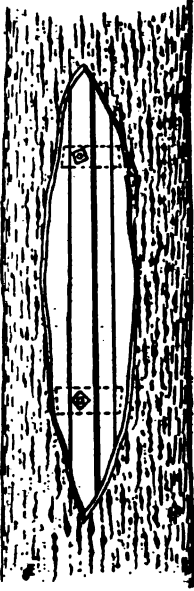


FIG. 21.—Surface view of a tree cavity filled with strips of wood, as shown in section in Figure 17; the surface has not yet been waterproofed. The broken lines show the position of the bolts and the broad washers. The washers should be of heavy iron and wide enough to reach across all the strips at the point where they are placed. The bolts should not pass through the unnailed joint (a-c) indicated in Figures 17 and 20.

strips of sufficient thickness to bring the surface to the cambium line nailed, screwed, or bolted over it to form an outside layer, as shown in Figure 20. Another (and usually better) method is to replace the strips numbered 11, 12, and 13, in Figure 20, with a layer of asphalt and sawdust, as described in the preceding section. The order in which the strips should be placed in the cavity is indicated by the order of the numbers in Figures 17, 18, 19, and 20. In long fillings, particularly in flexible branches, a bolt and

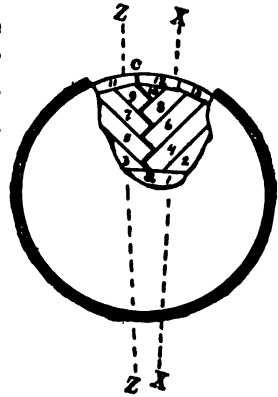


FIG. 20.—Section of a tree cavity filled with strips of wood, with a thin surface layer of strips (11, 12, 13). The broken line a-c indicates where a bolt, when necessary, should be located to hold the ends of a filling, as indicated in Figure 21. Occasionally it may be necessary to place bolts at both a-c and z-z. No bolt should pass through the unnailed zigzag joint a-o.

metal washer near each end of the filling, and perhaps another at the center, will prevent the ends or center working loose. Figures 19, 20, and 21 with their legends will explain the details of placing the bolts and washers.

GUYING.

Closely associated with the work already described, and often an indispensable adjunct, is the guying of limbs to prevent the splitting of the crotches or to check splitting that has already started.

A simple method of guying a crotch is to place a hook or ringbolt through each limb, with the hooks or rings in the two limbs toward each other and from 3 to 10 feet or more above the crotch (depending upon the size, position, and length of the limbs), and to tie these

hooks by means of a strong wire, wire cable, or chain (Figs. 22 and 23). Three or more adjoining limbs may be guyed collectively. The precautions already mentioned on pages 15 and 16 should always be followed, so far as they apply to boring and tarring the hole and countersinking the washers of the bolts. On smaller limbs heavy screw hooks can be substituted for the bolts.

A turnbuckle in the rod, bolt, cable, or wire guy will keep it taut at all times, as this permits a ready tightening of the guy within certain limits, should it later become advisable. If for any reason the guy is to be placed within a foot or two of the crotch, a single long bolt can often be used to better advantage, and sometimes a single long bolt can be used in place of a cable, a chain, or a turn-buckle rod where the guyed limbs are not likely to twist much as they sway in the wind.

Occasionally it may become necessary to guy a whole tree in order to prevent the breaking of the trunk when an unusually large cavity



FIG. 22.—Side view of limbs, showing the proper method of guying them above a weak or split crotch. The wire, cable, or chain guy is shown at *a*.

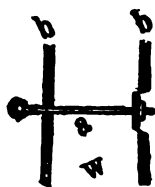


FIG. 23.—Sectional view of the limb of a tree, showing the details of placing an eyebolt of the type shown in Figure 22: *a*, Bolt; *b*, bark; *c*, wood.

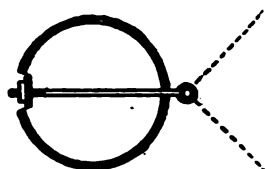


FIG. 24.—Sectional view of a tree trunk, showing the details of placing bolts for permanently guying a tree to the ground. This method of placing a bolt is used also in guying three or more limbs together. The broken lines indicate the guy wires.

leaves only a thin shell of sound wood, or to prevent a tree that has recently been set from tipping over before its roots have become well established. This can be accomplished by attaching four guy wires or ropes to the tree about half way from the ground to the top of the tree and having these slant downward at an angle of about 45° to four stout posts set firmly in the ground about equidistant around the tree (e. g., on the north, east, south, and west sides of the tree). If the guying is for temporary purposes only, two broad bands of leather or stout canvas or other strong material, each long enough to make a loop at least twice the diameter of the trunk or limb to be encircled and $\frac{1}{4}$ to 6 inches wide, may be passed around the tree or some favorably situated limb and two adjoining guys attached to

each loose loop. If a permanent guying is needed, two eyebolts (or hook bolts) can be placed through parallel creosoted holes in the trunk or limb about halfway up the tree, one 6 inches or more above the other. The eye of one bolt should be on the opposite side of the tree from the other. Two guys from two adjoining posts are attached to each eyebolt, the latter pointing halfway between the two posts to which the guys are to be attached (Fig. 24). The chafing of a limb against a guy should be prevented by padding the guy wire with a piece of garden hose or the limb with burlap, if the guy can not be so placed or braced as to clear all limbs.

Limbs or trees should never be guyed by passing wires, chains, or ropes tightly around them. These may eventually strangle the portions above the encircling band. Encircling fence wires, telegraph wires, or clotheslines may act in the same way, killing all parts of the tree beyond the ligature if they remain tightly drawn around the limb or trunk for any great length of time—often in less than a year.

WHEN REPAIR WORK MAY BE DONE.

As a general rule, tree surgery can be undertaken safely at almost any time of year when the sap is not running too actively and the weather is not cold enough to freeze cement, if this material is being used. In most trees the sap will interfere with the work only while the buds and leaves are expanding in the spring. Cement work will be ruined if it is frozen before it is set. It is not likely to be injured by frost after setting for a few days.

WHAT TREES ARE WORTH REPAIRING.

Most shade and ornamental trees with only a few dead limbs are unquestionably worth attention. Others that have many dead limbs or decayed areas may not be worth the expense of repairing them, particularly if they are rapid-growing short-lived trees. This point should be considered very carefully before any repair work is undertaken. Under no circumstances should a diseased or insect-infested tree be allowed to remain as a menace to near-by trees which are in a more healthy or entirely healthy condition. It should have all diseased or insect-infested bark, wood, or leaves removed and all freshly cut surfaces properly treated, or the entire tree should be removed. The diseased portions should be burned immediately. No one can decide better than the owner whether a tree is worth the expense of trying to save it, because the actual commercial value of an ornamental or shade tree usually has nothing to do with the decision. It is generally a question of esthetic value, or historic associations, or rarity of species, or location for shade. A man who has had experience in repairing mutilated or diseased trees may be able to say definitely

whether it is possible to save the tree, but the owner, who has to pay the bill, is the one who will have to decide whether the tree is worth the cost of repairing it. Often the owner will be better satisfied in the end to have a badly diseased or mutilated tree replaced by a healthy, perfect one. In expert hands the moving of large trees is no longer a hazardous undertaking.

COMPLETED WORK NEEDS WATCHING.

With the completion of repair work tree owners often fail to realize the importance of keeping close watch of their trees in order that defects which appear in the work may be remedied promptly and that new injuries elsewhere on the tree may have immediate attention. If a tree is of sufficient value to warrant proper and careful treatment, it certainly is worth the slight expense of subsequent annual or biennial inspection and the immediate repair of newly discovered injuries at a time when the expense necessary to keep the tree in good condition will be comparatively small.

PERSISTENCE OF SCARS.

It should be borne in mind that scars, where large limbs have been removed or large cavities filled or left open, will be unsightly spots for years, even under the best of conditions. If the scar is a large one, it may never entirely heal over before the tree succumbs to other agencies, and consequently it may remain a permanently conspicuous defect. It might so happen that a particularly large scar or filling would be too unsightly and conspicuous to please the owner. Here, again, greater satisfaction may be realized in the end by having the diseased tree replaced with a healthy one.

COMMERCIAL TREE-SURGERY WORK.

If a tree owner prefers to employ a commercial tree surgeon to attend to his trees it is advisable to have a definite written contract concerning at least certain important phases of the work, in addition to specifying the price and methods of payment. Besides the type or types of finished cavity work the following are suggested as points to be incorporated in the contract—points about which no reliable tree surgeon ought to object:

- (1) No climbing spurs shall be used on any part of a tree.
- (2) The shoes worn by the workman shall have soft soles.
- (3) In cavity work all diseased, rotten, discolored, water-soaked, or insect-eaten wood shall be removed and the cavity inspected by the owner or his agent before it is waterproofed.
- (4) Ordinary commercial shellac shall be applied to the cut edges of sapwood, bark, and cambium within five minutes after the final trimming cut is made or as soon afterwards as the surface becomes dry.

- (5) All cut surfaces shall be painted with shellac or commercial creosote, followed by thick coal tar or asphalt.
- (6) The contractor shall repair free of expense any defects that may appear in the work within one year.

Under certain conditions various modifications of these suggestions may be advisable, but alterations in Nos. 1, 2, 3, and 6 should be made with caution. If certain crotches are split or particular limbs on some trees need guying, it may be well to include these items in the contract. At times it may be desirable to include a statement of just what limbs shall be removed from particularly choice trees, and some provision should always be made for the regular inspection of the trees every one or two years unless the owner prefers to do this himself. The best results can generally be attained when payment is based upon the amount of work done, plus the cost of material used. Probably most persons, however, will prefer to have the trees examined and a definite contract price agreed upon before any work is undertaken.

CONCLUDING REMARKS.

At present tree-repair work has not received the recognition and approval from tree owners that it deserves. This at times may be due to unfavorable experiences with dishonest or ignorant tree surgeons, at other times to the reluctance of the owners to spend much money in preserving their trees, or from their ignorance of the benefits that may result when tree-repair work is properly done. Reliable tree surgeons are doing much in a practical way to educate the public as to the benefits of tree-repair work. Unfortunately, the unscientific or dishonest work of some others still is doing much to offset it.

A few States have laws regulating tree-repair work on a commercial basis. This is a decided step toward the betterment of tree-surgery methods.

The Department of Agriculture invites correspondence concerning methods in tree-repair work and will be prepared to advise for or against any particular method so far as experience and the results of experiments will permit. By cooperation of this sort tree-repair work ultimately ought to deserve and attain a much higher position in the estimation of the general public than it now holds.

Finally, tree owners are urged to remember at all times that the necessity of tree-repair work 15 or 20 years hence may be reduced very materially by promptly attending to the fresh injuries of to-day.

NOTE.—It is believed that the methods described in this bulletin are not covered by letters patent granted to any individual, firm, or corporation, but the Department of Agriculture assumes no responsibility in this connection.

PUBLICATIONS ON ALLIED TOPICS AVAILABLE FOR DISTRIBUTION.

Copies of publications listed below to which no price is attached will be sent free upon application to the Chief of the Division of Publications, Department of Agriculture, Washington, D. C., as long as the supply lasts. The editions of some of those listed are exhausted.

When the department supply is exhausted, available publications can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., by purchase only and at the prices noted here.

Send all remittances to the Superintendent of Documents direct. His office is not a part of the Department of Agriculture.

Blister Rust. Treatment of Ornamental White Pines Infected with Blister Rust. Pp. 20, figs. 12. (Department Circular 177.)

Blister Rust, White Pine. Pp. 15, pl. 1, figs. 5. (Farmers' Bulletin 742.) Price 5 cents.

Chestnut Bark Disease. Pp. 10, pls. 4. Separate 598, Yearbook for 1912. Price 10 cents.

Chestnut Bark Disease, Japanese, Immunity. Pp. 4. (Bureau of Plant Industry Bulletin 121, part 6.) Price 5 cents.

Chestnut Timber Killed by the Bark Disease, Uses. Pp. 24, figs. 8. (Farmers' Bulletin 582.) Price 5 cents.

Chestnuts and Oaks, Death Due to Armillaria mellea. Pp. 9, pla. 2. (Department Bulletin 89.) Price 5 cents.

Coniferous Seedlings, Damping-off, Control. Pp. 32, pls. 2, fig. 1. (Department Bulletin 453.) Price 5 cents.

Farmstead, Beautifying. Pp. 65, figs. 66. (Farmers' Bulletin 1087.)

Fungicides and Their Use in Preventing Diseases of Fruits. Pp. 32, figs. 17. (Farmers' Bulletin 243.) Price 5 cents.

Jack Pine, Pathology, Observations. Pp. 10, pl. 1, figs. 4. (Department Bulletin 212.)

Mistletoe Injury to Conifers in the Northwest. Pp. 39, pls. 4, figs. 27. (Department Bulletin 360.)

Pine, Disease Caused by Cronartium pyriforme. Pp. 20, pls. 2, fig. 1. (Department Bulletin 247.)

Pruning. Pp. 35, figs. 25. (Farmers' Bulletin 181.)

Red Gum, Sap-Rot and Other Diseases. Pp. 37, pls. 8. (Bureau of Plant Industry Bulletin 114.) Price 15 cents.

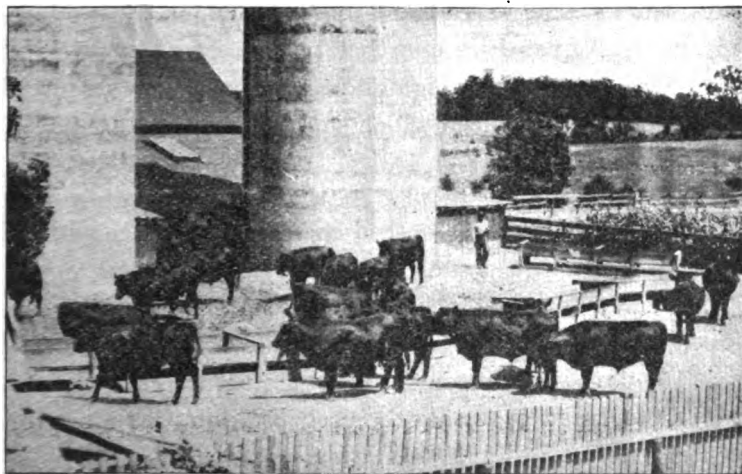
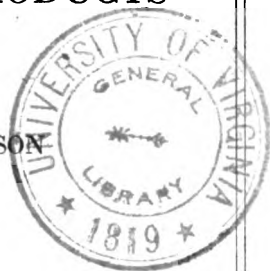
Street Trees. Pp. 58, figs. 37. (Department Bulletin 816.) Price 15 cents.



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FEEDING COTTONSEED PRODUCTS TO LIVESTOCK

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FARMERS' BULLETIN 1179
UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Animal Industry
JOHN R. MOHLER, Chief

Washington, D. C.

November, 1920

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THE FOLLOWING POINTS have been determined from experiments and practical feeding operations. They should be kept in mind and carefully followed in feeding cottonseed products to livestock:

- (1) Do not feed cottonseed meal to young calves.
- (2) Horses and pigs should be fed cottonseed products only in small quantities and then with great precaution.
- (3) Procure prices on high-grade and low-grade cottonseed meal and choose the feed which supplies protein at the least cost.
- (4) For feeding cattle:
 - (a) One pound of cottonseed meal is usually considered worth as much as 2 pounds of corn or its equivalent.
 - (b) Heavy rations of cottonseed meal should be discontinued after 100 to 120 days when dry roughage is fed, and after 150 days when succulent feeds are used.
 - (c) Cottonseed cake may be used profitably as a supplemental feed for fattening cattle on pasture.
- (5) In sections where much corn, stover, fodder, timothy, or other carbohydrate feed is used it is extremely important that some feed like cottonseed meal be used.
- (6) Cottonseed meal stimulates the appetites of fattening animals and causes them to consume more feed and likewise to make greater gains.
- (7) Cottonseed meal is a very valuable protein feed for dairy cows. One pound of good-quality cottonseed meal is usually considered equal to 2 pounds of wheat bran for milk production.

FEEDING COTTONSEED PRODUCTS TO LIVESTOCK.¹

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VALUE OF COTTONSEED PRODUCTS AS LIVESTOCK FEEDS.

Cottonseed products have been used extensively for stock feeding in the South for many years. During more recent times their use has become general in many sections outside the Cotton Belt. The demand from foreign countries is strong, despite the fact that these products cost considerably more there than they do in this country. European feeders, as a rule, have placed more value on high-protein feeds than the average American livestock man.

Another reason why cottonseed products are of such great importance, in addition to their high-protein content, is their immense production. Although the production of cotton has shown a slight decrease during the last 10 years, the decrease has not been so marked as has been the case with flaxseed, from which linseed meal² is made. Several new protein feeds, like peanut cake, copra cake, and fish meal, have been offered on the market during the last few years, but with the average stockman they have not been received with so much favor as cottonseed meal or linseed meal, due in part to their unknown value. These newer products, however, promise to become of more importance in the future, because some of them have distinct advantages over cottonseed products for certain classes of farm animals.

COMPOSITION OF COTTONSEED PRODUCTS.

There are a large number of cottonseed products used as livestock feeds. Both concentrates and roughages are included. All the concentrate products have the same general characteristics and qualities, their chemical composition depending mainly upon the form of manu-

¹ This bulletin supersedes Farmers' Bulletin 655, "Cottonseed Meal for Feeding Beef Cattle."

² This product is also known as "oil meal," and "new-process" and "old-process" meal.

facture and the thoroughness in separating out the hulls. Among the more common cotton products used as feeds are cotton seed, cottonseed meal and cake, and cottonseed hulls. Table 1 gives analyses representing these products, which have been put on the market by manufacturers to conform to the definitions adopted by the Association of Feed Control Officials of the United States.

TABLE 1.—Composition of cottonseed products.¹

[Pounds of nutrients in 100 pounds.]

Product.	Water.	Ash.	Crude protein.	Carbohydrates.		Fat (ether extract).
				Fiber.	Nitrogen-free extract.	
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Cotton seed.....	6.6	3.7	21.7	19.7	26.9	21.4
Cottonseed meal:						
Choice.....	6.4	5.9	43.3	10.0	25.7	8.7
Prime.....	6.6	6.1	38.9	13.2	28.5	6.7
Good.....	6.5	5.8	37.8	13.6	30.6	5.7
Cold-pressed cottonseed cake.....	6.2	4.7	25.8	24.0	31.5	7.8
Cottonseed hulls.....	8.5	2.4	2.8	48.6	37.4	.3

¹ Furnished by the Bureau of Chemistry, United States Department of Agriculture.

GRADES AND CLASSES OF COTTONSEED PRODUCTS.

Formerly cotton seed (uncrushed) was used quite extensively as a feed for livestock. Its value as a source of cottonseed oil and its utilization for commercial purposes has greatly decreased the amount fed in the form of seed. Cottonseed products have taken the place of the seed as a feedstuff. Several feeding tests have indicated that 1 pound of good-quality cottonseed meal is equal to nearly 2 pounds of cotton seed as a feed for fattening steers. Large rations of cotton seed tend to produce scours, but when used in quantities up to 5 or 6 pounds there is little or no trouble from this source.

Cotton seed contains about 21 per cent fat or oil and nearly 22 per cent crude protein. Compared with a good grade of cottonseed meal it contains about half as much protein and about two and one-half times the content of oil.

A ton of cotton seed will yield approximately the following quantities of products:³

	Pounds.
Linters or short fiber.....	110
Hulls.....	514
Cake or meal.....	954
Crude oil.....	303
Loss in manufacture.....	119
Total.....	2,000

Cottonseed cake is made from the residue which remains after the oil has been extracted from the seed. Ordinarily the greater

³ Average for the 5 years 1914-15 to 1918-19 as compiled by the Bureau of Markets, United States Department of Agriculture, from Bureau of Census figures and estimates.

part of the hulls is removed before the oil is extracted. When this is done the amount of crude fiber in the resulting cake is proportionately smaller. The hulled kernels are crushed, heated, and subjected to great pressure to remove the oil. The residue when of good quality should be a hard, boardlike cake of a yellowish color. The color is often an indication of the quality. The presence of hulls causes the cake to become dark. A dark color may also be caused by overheating during the pressing process or by fermentation, each of which lessens the feeding value.

Cottonseed cake and cottonseed meal are practically one and the same thing; that is, the meal is the cake in a ground form. The meal is most commonly used, but the cake has a distinct advantage in certain cases. European buyers show a preference for the cake for the reasons that there is less loss in handling, it is easier to judge the quality, and because the cake is better adapted for feeding alone or on the ground.

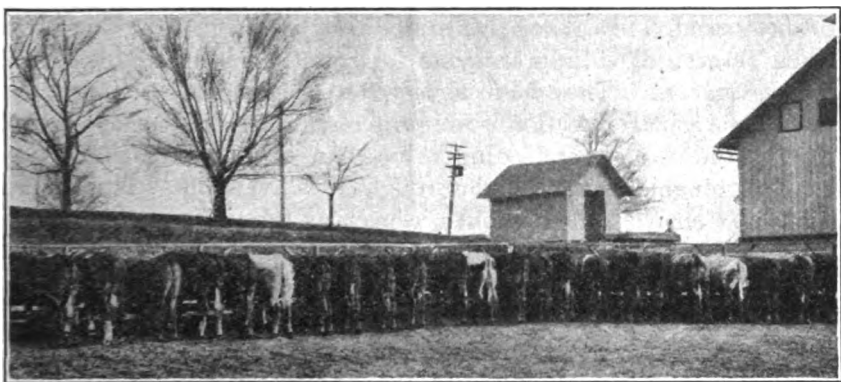


FIG. 1.—Tennessee steers, fattened chiefly upon cottonseed meal and silage. (Courtesy of the Tennessee Experiment Station.)

In the United States the cake is preferred by men who feed their cattle in the open where the wind may blow the meal away. On the range or pasture the cake is often broken up and fed in troughs or spread upon the ground. If meal were used, the loss in feeding in this manner would be very large.

There are many grades and classes of cottonseed products sold on the market. The grades as classified and described by the Association of Feed Control Officials of the United States are as follows:

1. Cottonseed meal.
2. Choice cottonseed meal.
3. Prime cottonseed meal.
4. Good cottonseed meal.
5. Cottonseed feed.
6. Cold-pressed cottonseed (cake).
7. Ground cold-pressed cotton seed.

Cottonseed meal is a product of the cotton seed only, composed principally of the kernel with such portion of the hull as is necessary in the manufacture of oil; provided, that nothing shall be recognized as cottonseed meal that does not conform to the foregoing definition and that does not contain at least 36 per cent of protein.

Choice cottonseed meal must be finely ground, not necessarily bolted, perfectly sound and sweet in odor, yellow, free from excess of lint, and must contain at least 41 per cent of protein.

Prime cottonseed meal must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, yellow, not brown or reddish, free from excess of lint, and must contain at least 38.6 per cent of protein.

Good cottonseed meal must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, and must contain at least 36 per cent of protein.

Cottonseed feed is a mixture of cottonseed meal and cottonseed hulls, containing less than 36 per cent of protein.

Cold-pressed cotton seed is the product resulting from subjecting the whole undecorticated cotton seed to the cold-pressure process for the extraction of oil, and includes the entire cotton seed less the oil extracted.

Ground cold-pressed cotton seed is the ground product resulting from subjecting the whole undecorticated cotton seed to the cold-pressure process for the extraction of oil, and includes the entire ground cotton seed less the oil extracted.

Cottonseed hulls are the roughage product of cottonseed-oil manufacture. The hulls are removed from the cotton seed before the oil is extracted. They have a very low-protein content and should be fed only in connection with protein-rich feeds. As a roughage the hulls have a lower feeding value than oat straw or corn stover, but are valuable where no other roughage is available. This product is used extensively in the South, especially for steer feeding.

Cottonseed-hull bran is ground cottonseed hulls from which the lint has been removed. The feeding value of the bran is not appreciably greater than that of ordinary cottonseed hulls.

POISONOUS EFFECTS OF COTTONSEED PRODUCTS.

Cottonseed products, though valuable feeds, are not always safe feeds, especially when fed to certain animals. Experience has shown that their use as a feed for young calves and pigs may result fatally. Just what causes the harmful effects is not known. The products may be used for a limited time with no visibly harmful effects, but their continued use may be fatal. Until more is learned concerning the toxicity of cottonseed meal, it is well to feed it sparingly and with extreme caution to young calves and pigs. It is less harmful to older cattle, but when fed continuously and in large amounts for long periods it may also prove to be harmful even to them. Formerly steers were frequently fed, in the vicinity of cotton-oil mills, as much as from 12 to 15 pounds of cottonseed meal per head per day. As a result of such heavy feeding many became blind, exhibited a staggering gait, and occasionally the legs swelled below the hocks. Some died, while others ceased to gain in weight, went off feed, and then rapidly lost flesh. Even though the feed was changed much

trouble was experienced in getting the animals back to a normal appetite and a thrifty condition. Horses and mules may also be seriously affected by the toxic properties of cottonseed meal when it is used in more than limited amounts.

Cottonseed meal, fed in small or moderate amounts, is constipating. For that reason it should be used with more laxative feeds, such as silage, and as a supplement to other concentrates. Its rational use with a variety of feeds will usually overcome the difficulty.

ECONOMY OF USING HIGH-GRADE COTTONSEED PRODUCTS.

Cottonseed products containing a high percentage of protein command relatively high prices, but judged from the cost of the protein contained, they are comparatively cheap. Some feeders prefer to buy the lower-grade products, believing them to be more economical than the better grades. From the standpoint of the cost of the protein in the feeds such men are usually deceiving themselves. These products are usually purchased for their protein content and prices paid should be based on the protein contained in them. To show the value per pound of the protein in feeds at various prices and containing varying guaranteed analyses of protein, Table 2 has been prepared.

TABLE 2.—Cost of protein per pound in feeds at various prices per ton.

Cost of feed per ton.	Per cent of protein in feeds.										
	12	16	20	24	28	32	36	38	41	43	45
	Cost per pound of protein.										
	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
\$25.00	10.42	7.82	6.25	5.23	4.47	3.91	3.47	3.29	3.05	2.91	2.77
30.00	12.50	9.38	7.50	6.25	5.36	4.69	4.16	3.95	3.66	3.48	3.38
35.00	14.58	10.94	8.75	7.29	6.25	5.47	4.86	4.61	4.26	4.07	3.89
40.00	16.67	12.50	10.00	8.33	7.14	6.25	5.55	5.26	4.88	4.65	4.44
45.00	18.75	14.06	11.25	9.38	8.03	7.03	6.25	5.92	5.49	5.23	5.00
50.00	20.83	15.63	12.50	10.42	8.93	7.81	6.94	6.58	6.09	5.81	5.55
55.00	22.91	17.19	13.75	11.46	9.82	8.59	7.64	7.24	6.71	6.40	6.11
60.00	25.00	18.75	15.00	12.50	10.71	9.38	8.33	7.89	7.32	6.97	6.67
65.00	27.08	20.31	16.25	13.54	11.67	10.16	9.03	8.55	7.92	7.56	7.22
70.00	29.16	21.87	17.50	14.58	12.50	10.94	9.72	9.21	8.53	8.14	7.78
75.00	31.25	23.44	18.75	15.62	13.39	11.72	10.41	9.87	9.14	8.72	8.33
80.00	33.33	25.00	20.00	16.67	14.28	12.50	11.11	10.53	9.75	9.32	8.89
85.00	35.41	26.56	21.25	17.71	15.18	13.28	11.80	11.18	10.36	9.88	9.44
90.00	37.50	28.12	22.50	18.75	16.07	14.06	12.50	11.84	10.97	10.48	10.00
95.00	39.58	29.69	23.75	19.79	16.43	14.84	13.19	12.50	11.58	11.04	10.55
100.00	41.67	31.25	25.00	20.83	17.86	15.62	13.89	13.16	12.19	11.63	11.11

The poorer grades of cottonseed meal or cake usually sell only a little lower than the prices for the higher-grade products. By obtaining commercial prices on both high-grade and low-grade products and referring to Table 2, one can ascertain approximately which feed will provide protein at the least cost. It must be remembered,

however, that the feeding values of different feeds having essentially the same coefficients of digestibility are not exactly proportional to their respective protein contents. A low-protein feed usually has a higher content of carbohydrates, which may partially make up in feeding value for the difference in protein content.

Good cottonseed meal contains three times as much digestible protein and as much digestible carbohydrates and fat combined as there is in wheat bran. One pound of cottonseed meal will balance as much corn as 3 pounds of bran.

Sometimes the analysis of cottonseed meal offered for sale is given on the tag in terms of nitrogen or of ammonia, or it may be quoted in those terms by feed dealers. One may readily determine the protein content by using the following factors:

Multiply the nitrogen by 6.25. For example, if the analysis is given as 6 per cent nitrogen, then the pounds of protein in 100 pounds of the meal will be 6×6.25 , which is 37.50. This means that it is a good grade of meal.

If the analysis is given in terms of ammonia, multiply the per cent of ammonia by 5.15. For example, if the analysis is given as 7.5 per cent ammonia, the protein in 100 pounds of the meal will be 7.5×5.15 , which is 38.62, meaning that it is a good grade of meal.

COTTONSEED PRODUCTS FOR VARIOUS CLASSES OF LIVESTOCK.

The rations given in the succeeding pages may be used as the average and may be adjusted to suit local conditions. If the suggested rations can not be used, one may substitute other feeds of the same general character as those included in the rations outlined. These rations are primarily designed to show the proper proportions in which to use cottonseed products and no attempt is made to cover all conditions.

In discussions of feeding cottonseed products, the quantities for the different classes of animals are given in pounds. While it is important to weigh the meal as fed, yet it may be entirely satisfactory merely to weigh at frequent intervals the contents of a certain measure or vessel. Table 3, giving weights and measures, may be helpful along this line.

TABLE 3.—*Equivalent weights and measures of cottonseed products.*

Product.	One quart weighs—	One pound measures—
	Pounds.	Quarts.
Cotton seed.....	0.8	1.3
Cottonseed meal.....	1.5	.7
Cottonseed hulls.....	.3	3.3

FATTENING CATTLE.

It is for fattening cattle that cottonseed concentrates serve their greatest usefulness. A very large percentage of cottonseed feeds is used for cattle fattened for market. The usual feeding period for this class of cattle is from 90 to 120 days, and during that period comparatively large quantities of cottonseed cake or meal are used. When steers are not fed more than 7 pounds of cottonseed meal a day, they can usually be fed from 100 to 120 days without showing any signs of cottonseed-meal poisoning. If silage or other succulent feed is given as roughage, the meal can be fed longer without harmful results.

When cattle are fed a ration composed only of cottonseed hulls and meal, they usually make good daily gains for the first 60 days,

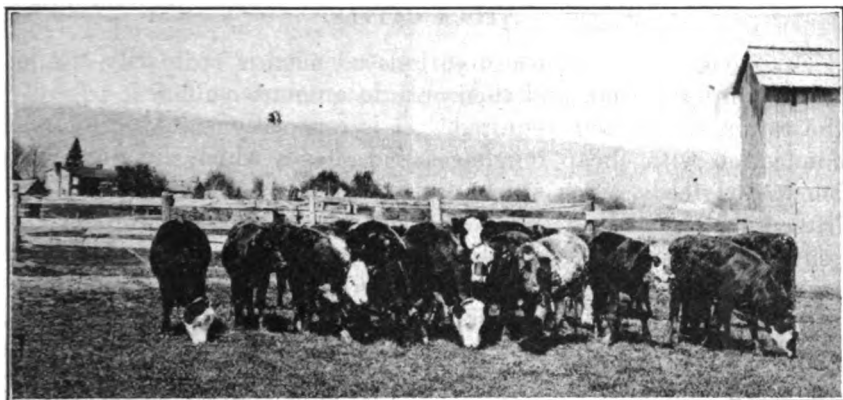


FIG. 2.—These fat yearling steers, fed in West Virginia, received a ration of silage and cottonseed meal.

after which the gains diminish rapidly, and after 90 to 100 days they are seldom satisfactory. For a short feeding period cottonseed hulls and meal give satisfactory results. If the roughage is silage instead of hulls, the daily gains are more nearly uniform throughout the feeding period, and if care is used in feeding the meal it can be fed for 150 days without ill effects.

In many of the leading cattle-feeding sections of the Corn Belt cottonseed meal is used extensively, especially as a supplement to silage. Where alfalfa is grown successfully, as in the western part of the Corn Belt, little or no cottonseed meal is used. Not only has it proved to be economical for fattening cattle in the winter, but many feeders use the cake as a supplement to grass. Its use in most feeding sections is limited to 3 or 4 pounds a day for cattle averaging 1,000 pounds live weight.

One reason why cottonseed meal is highly prized for feeding cattle is that it puts on a glossy finish, which makes them sell better than

cattle having harsh, rough coats. There is also a tendency for cattle receiving cottonseed meal to put on a smooth, even covering of firm flesh.

Suggested rations for fattening steers averaging 1,000 pounds in weight.

RATION 1.		RATION 3.	
	Pounds.		Pounds.
Corn (or sorghum) silage	25	Sorghum (or kafir) silage	35
Mixed hay	10	Grass hay or stover	6
Corn	10	Cottonseed meal or cake	4
Cottonseed meal	3	Kafir (or milo) chops	10
RATION 2.		RATION 4.	
	Pounds.		Pounds.
Wet beet pulp	80	Sorghum silage	30
Prairie hay	10	Grass hay or stover	6
Beet molasses	4	Velvet beans in pod	6
Cottonseed meal	4	Cottonseed meal	3

STOCK CATTLE.

For stock cattle the use of cottonseed meal is ordinarily confined to the winter period, and then only in amounts sufficient to add to the ration the protein required. It is especially valuable to use in connection with cheap roughages and silages which are highly carbonaceous feeds. For stock cattle weighing 500 to 750 pounds, from 1 to 2 pounds of the meal is enough to balance properly most roughage rations. When legume hays are used the cottonseed meal may be materially reduced and sometimes entirely eliminated to advantage. If alfalfa or clover constitutes half or more of the roughage ration, there is little or no need for the use of additional protein-rich feeds.

Few combinations are more economical than a ration of corn silage and cottonseed meal for wintering stock cattle. One to two pounds of cottonseed meal combined with whatever silage stock steers will eat will keep them in good, thrifty condition and cause them to make a profitable gain. The cost of wintering such cattle can usually be lessened by permitting the steers to run in the stalk fields and giving them feed at night only. Straw and other roughages which can not be used to advantage in any other way may be fed with silage and cottonseed meal.

Suggested rations for wintering stockers averaging 750 pounds in weight.

RATION 1.		RATION 3.	
	Pounds.		Pounds.
Corn (or sorghum) silage	25	Corn stover silage	25
Oat or wheat straw	Unlimited.	Grass hay	6
Cottonseed meal	$\frac{1}{2}$ to $1\frac{1}{2}$	Cottonseed meal	$\frac{1}{2}$ to $1\frac{1}{2}$
RATION 2.		RATION 4.	
	Pounds.		Pounds.
Corn (or sorghum) silage	25	Cottonseed cake	1 to $1\frac{1}{2}$
Oats or corn	2	Silage, to supplement winter	
Cottonseed meal	$\frac{1}{2}$	pastures	15 to 20
Straw or stover	Unlimited.		

BREEDING CATTLE.

In feeding cottonseed meal to beef cows, two classifications may be made—dry cows and cows that nurse calves. The dry cows may be handled in much the same manner as stock cattle. The amount of cottonseed meal that should be fed to this class of cows depends on the other feeds used. Some feeders use excessive quantities of cottonseed meal, causing the cost of the ration to become uneconomically high. From 1 to 1½ pounds of cottonseed meal may be fed daily with other feeds, such as corn silage and good hay. Where corn silage is available, a good ration for breeding cows would be 25 to 30 pounds silage, from 1 to 1½ pounds cottonseed meal or cake, and other roughage; such as stalk fields, corn stover, hay, or straw.

Cows that are nursing calves should receive more protein supplements than dry cows, but the amounts fed should not be greater than is necessary to balance properly the other feeds, which may consist largely of roughages. Ordinarily beef cows raising calves are fed not more than 2 pounds each daily, and then only during the winter period.

Suggested rations for wintering beef breeding cows averaging 1,000 pounds in weight.

RATION 1.		RATION 3.	
	Pounds.		Pounds.
Corn silage.....	25 to 30	Grass hay or stover.....	18 to 20
Cereal straw or stover.....	Unlimited.	Cottonseed meal or cake....	1½ to 2
Cottonseed meal.....	1 to 1½		
RATION 2.		RATION 4.	
	Pounds.		Pounds.
Corn (or sorghum) silage....	25 to 30	Kafir (or milo) silage.....	30 to 35
Cottonseed meal.....	1 to 1½	Kafir or milo stover or cereal	
Winter pasture.		straw.....	Unlimited.
		Cottonseed meal or cake....	1½

CALVES.⁴

It is well not to use cottonseed meal at all until the calf is 3 to 4 months old, and then only in a limited way. By the time the calf is 1 year old it may be eating from ½ to 1½ pounds a day with comparative safety. For young calves, linseed meal is by far a better feed and is to be preferred. Contrasted with cottonseed meal, linseed meal contains no toxic substances, and the high content of mineral matter makes it especially valuable for young stock of all kinds. Cows suckling calves may be fed cottonseed meal in moderate amounts without any detrimental effect to the calves.

DAIRY COWS.

Dairy cows are often fed comparatively large quantities of cottonseed products, sometimes for long periods of time. The amount of cottonseed meal to use should be regulated partly by the production

⁴Those interested in beef production should send for Farmers' Bulletin 1135, "The Beef Calf, Its Growth and Development," and Farmers' Bulletin 1073, "Growing Beef on the Farm."

of butterfat and the nature of the other feeds used. One must remember also that cottonseed meal or cake is constipating and should be used with more laxative feeds, such as linseed meal, wheat bran, silage, or roots. When used in large quantities for dairy cows it produces hard, tallowy butter, light in color and poor in flavor. When used in moderate amounts the quality of the products need not be impaired and in many instances can be improved if the other feeds tend to produce soft butter. The cottonseed products are heavy, concentrated protein feeds and for best results should be used with lighter and more bulky feeds. For average dairy cows the use of cottonseed products should be limited to 2 or 3 pounds a day when used in connection with other concentrates.

Suggested rations for a 1,000-pound dairy cow, giving 25 pounds of 4 per cent milk daily.⁵

RATION 1.		RATION 3.	
	Pounds.		Pounds.
Clover hay.....	10	Barley (or oat) hay.....	15
Corn (or sorghum) silage.....	35	Clover or alfalfa hay.....	5
Ground corn.....	3	Dried beet pulp (soaked).....	5
Wheat bran.....	2	Cottonseed meal.....	2
Cottonseed meal.....	2		
RATION 2.		RATION 4.	
	Pounds.		Pounds.
Roots (mangels).....	20	Corn (or sorghum) silage.....	35
Mixed hay.....	15	Grass hay.....	10
Corn-and-cob meal.....	2	Corn chops.....	4
Crushed barley.....	3	Cottonseed meal.....	2½
Cottonseed meal.....	2½		

BULLS AND YOUNG STOCK.

It is not advisable to feed bulls more than a very limited ration of cottonseed meal; many practical stockmen say that it impairs the breeding qualities of the animal. Bulls should receive a sufficiency of protein-rich feeds, but cottonseed meal should be used only in moderate amounts. Throughout the winter it may be used for the bull to the extent of 1½ or 2 pounds along with other concentrates, such as bran, corn, and oats.

It is highly important that young stock of both beef and dairy breeds intended for breeding purposes be supplied with an abundance of protein and mineral matter. Although cottonseed products are not so valuable as linseed meal for this purpose, they are especially valuable as a source of protein. As previously stated, their use should be very limited before the calves are 4 months old, but may be increased to 1½ pounds by the time the animal is a year old.

⁵ Those desiring detailed information on this subject should send for Farmers' Bulletin 743, "The Feeding of Dairy Cows."

HOGS.

As stated, hogs are especially susceptible to poisoning from cottonseed meal. Cottonseed products to the extent of one-fourth of the concentrate ration have been used for short periods of 40 days or less, frequently without harmful effects. But usually if the cottonseed meal is fed for more than 5 or 6 weeks, harmful results will follow. By decreasing the amount of meal, or by supplying pasture or other succulent feeds, the poisoning may be delayed. As yet no satisfactory way of neutralizing the poison has been found. It would be well for the experienced as well as the inexperienced swine feeder to let cottonseed meal alone and use such safe protein feeds as tankage, fish meal, linseed meal, and skim milk.

Before the use of cottonseed meal became general, cattle feeders believed that hogs following the steers in the feed lot might become poisoned. Experience has shown, however, that no detrimental results follow this practice. Evidently the toxic substances have become neutralized in the process of digestion. When the meal or cake fed to the cattle is not accessible to the pigs, there is no danger that the pigs will be poisoned by eating the waste feed in the droppings.

HORSES.

Cottonseed meal has met with considerable disfavor among horse feeders because they say it causes digestive disorders. There may be considerable truth in this statement, because many horses have been killed by the feeding of excessive quantities of cottonseed meal. In too many cases, however, the quality of cottonseed meal has not always been the best or the quantity safeguarded. Horses are very susceptible to injury from eating moldy feed and this applies particularly to the use of cottonseed products. In the South, plantation owners often feed their mules on cottonseed meal in conjunction with corn, with apparently good results. Quite often it is used in connection with blackstrap molasses and grain.

The use of cottonseed meal for horses and mules can be recommended only in limited quantities, and then care must be exercised in securing cottonseed meal of good quality. Horses should be started on the meal gradually and it should always be used as a supplement to a carbonaceous feed, such as corn. The meal is not relished by horses and, being unpalatable, it should be well incorporated with other feeds. While it has been fed in larger quantities in a few cases, the best results may be obtained by limiting the amount to 1 pound per 1,000 pounds live weight, and by giving special attention to the horses receiving the cottonseed meal.

Suggested rations for a 1,000-pound horse at medium work.

RATION 1.		RATION 3.	
	Pounds.		Pounds.
Oats.....	12	Rollod barley.....	10
Timothy hay.....	10	Oat hay.....	10
Cottonseed meal.....	4	Cottonseed meal.....	4
RATION 2.		RATION 4.	
	Pounds.		Pounds.
Shelled corn.....	10	Shelled corn.....	6
Molasses.....	2	Wheat bran.....	4
Grass hay.....	8	Cottonseed meal.....	1
Cottonseed meal.....	1	Timothy hay.....	10

SHEEP.

In feeding sheep it is highly important to balance properly the rations used. Protein-rich concentrates can be used advantageously for this purpose. Cottonseed meal and cake have been used for fattening sheep with fairly satisfactory results, but not so extensively as linseed meal. In limited quantities it may be used to advantage.

Cottonseed meal and cake are also used to advantage in limited quantities for breeding ewes. One-half pound a day meets their requirementse.

Sheep should be started on cottonseed products in small quantities. Lambs when on full feed should receive not more than one-third of a pound a day when fed no other concentrates, and only one-eighth to one-fourth of a pound in combination with other grains. It is advisable to use cottonseed meal in connection with corn, oats, or similar grain. Sheep usually relish cottonseed cake more than the finely ground meal.

Suggested rations for 60-pound fattening lambs.

RATION 1.		RATION 3.	
	Pounds.		Pounds.
Shelled corn.....	1.0	Corn silage.....	1.2
Grass hay.....	1.0	Barley.....	1.0
Cottonseed meal.....	.3	Cottonseed meal.....	.2
		Clover hay.....	.6
RATION 2.		RATION 4.	
	Pounds.		Pounds.
Shelled corn.....	1.2	Wet beet pulp.....	3.0
Alfalfa.....	.4	Barley.....	.6
Corn silage.....	.6	Cottonseed meal.....	.3
Cottonseed meal.....	.2	Prairie hay.....	1.0

COTTONSEED MEAL OR CAKE FOR PASTURE FEEDING.

For years feeders, of the Southwest particularly, have used cottonseed cake for feeding steers on pasture in the fall and winter (at times when the grass was covered with snow) and also during periods of

grass shortage. The fattening of cattle on grass with cottonseed cake during the spring and summer months has during more recent years been found to be an economical practice. The cake is usually preferred to the meal for grass feeding. In regard to feeding cake in preference to meal, a former publication of the bureau is here quoted: *

There are several advantages in feeding cake in place of meal, especially in summer feeding. A rain does not render the cake unpalatable, but it will often put the meal in such a condition that the cattle will not eat it. Again, no loss is incurred with the cake during windy days, whereas the meal, when fed in the open pasture, is sometimes wasted on account of the high winds. Furthermore, the cake requires chewing before being swallowed and therefore must be eaten very much slower than the meal, so when a number of steers are being fed together the greedy one has little chance to get enough cake to produce scours. When cottonseed meal is fed, the greedy steer often scours, because he can bolt the meal and get more than his share; this not only injures the steer but makes the bunch "feed out" unevenly.

In experiments conducted in the Southeast by the Bureau of Animal Industry in which the cake was fed in troughs in the pasture, it was found after several years' work that the feeding of cottonseed cake to cattle on pasture caused the cattle to fatten more rapidly, to develop greater finish, and to make greater profits in most cases than with similar cattle which received pasture alone. The value of the cake as a supplement to pasture, of course, depends to a considerable extent upon the nature of the pasture grasses, its use for legumes not being so profitable as with true grasses. As a rule, however, the feeding of cottonseed cake on good grass pasture is not highly profitable. The stage of maturity of the grass is also of significance in this connection, because dry, mature grass is of a more carbonaceous nature than grass in earlier stages of growth.

EXPERIMENTAL RESULTS SHOWING THE VALUE OF COTTONSEED PRODUCTS IN RATIONS.

VALUE OF PROTEIN SUPPLEMENT FOR STEER FEEDING.

Numerous experiments have conclusively shown the value of protein supplements when added to rations deficient in protein. The following summary covers four experiments, averaging 132 days, with 2-year-old steers, in which a nitrogenous supplement was added to a ration of corn and a carbonaceous roughage.

The addition of the protein supplement increased the average daily gain 0.60 pound a day, and reduced the total concentrates required to produce 100 pounds gain from 1,082 pounds to 862 pounds and the roughage from 522 pounds to 402 pounds.

* From Bureau of Animal Industry Bulletin 131 "Beef Production in Alabama."

TABLE 4.—Summary of four feeding experiments showing the value of a protein supplement.¹

Ration.	Number of steers.	Average daily gain.	Feed per 100 pounds gain.		
			Concentrates.		Carbonaceous roughage.
			Corn.	Protein supplement.	
Corn and carbonaceous roughage.....	44	Pounds. 1.60	Pounds. 1,082	Pounds.	Pounds. 522
Corn, protein supplement, and carbonaceous roughage.....	54	2.20	766	96	402

¹ Bulletin references: Illinois Experiment Station Bulletin 83; Indiana Experiment Station Bulletin 115; Nebraska Experiment Station Bulletins 90 and 93.

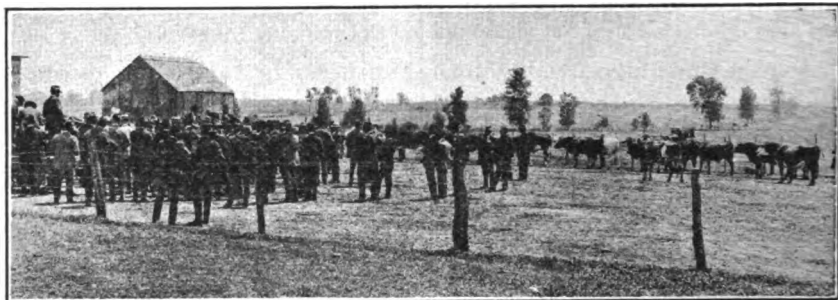


FIG. 3.—Inspecting cattle and hearing reports of experimental work at Canton, Miss. The steers were fattened largely on silage and cottonseed meal.

COTTONSEED MEAL COMPARED WITH OTHER CONCENTRATES FOR DAIRY COWS.

At the New Jersey station 4 cows were fed for 66 days on a ration of corn silage and corn stover, with either cottonseed meal alone or a mixture of equal parts of wheat bran and dried brewers' grains for the concentrate allowance, the latter being fed alternately, with the result shown in Table 5.

TABLE 5.—Summary of feeding experiment showing relative value of cottonseed meal and other concentrates.¹

Feed.		Average daily yield.	
		Milk.	Butterfat.
Ration 1:	Pounds.	Pounds.	Pounds.
Corn silage.....	36	22.7	0.96
Corn stover.....	6		
Cottonseed meal.....	4.5		
Ration 2:	Pounds.	Pounds.	Pounds.
Corn silage.....	36	23.9	0.95
Corn stover.....	6		
Wheat bran.....	5		
Dried brewers' grains.....	5		

¹ From New Jersey Experiment Station Report for 1903.

In this experiment 4.5 pounds of cottonseed meal were found to be practically equal to 5 pounds of wheat bran and 5 pounds of dried brewers' grains. Most dairymen conclude that 1 pound of good-quality cottonseed meal is equal to 2 pounds of wheat bran for milk production.

PASTURE SUPPLEMENTED WITH COTTONSEED CAKE.

TABLE 6.—*Value of cottonseed products as a supplement to pasture in steer feeding.*¹

Lot.	Ration.	Average daily gain.	Daily ration of concentrates.	Selling price of cattle.	Profit per steer.
		Pounds.	Pounds.		
Lot A.....	Pasture alone.....	1.52		\$3.66	\$2.86
Lot B.....	Pasture plus cottonseed cake..	2.32	3.31	4.53	10.42

¹ From Bureau of Animal Industry Bulletin 131.

The addition of 3.31 pounds of cottonseed cake a day as a supplement to the grass increased the daily gain 0.80 pound or from 1.52 to 2.32. The use of the protein supplement increased the selling prices of the cake-fed cattle, so that they made a greater profit than the cattle receiving grass alone. (See Table 6.)

COTTONSEED MEAL AS A SUPPLEMENT TO CORN AND A CARBONACEOUS ROUGHAGE FOR FATTENING LAMBS.

In Table 7 the results of four experiments, averaging 80 days, show the effect of adding cottonseed or linseed meal to a ration of timothy hay and corn.

TABLE 7.—*Effect of cottonseed meal or linseed meal as a supplement to timothy hay and corn for lambs.*¹

Ration.	Daily gain.	Feed for 100 pounds gain.	
		Concentrates.	Hay.
	Pounds.	Pounds.	Pounds.
Corn.....	1.2	0.23	520
Timothy hay.....	1.0		
Corn.....	1.2	.30	463
Timothy hay.....	1.0		
Cottonseed (or linseed) meal.....	.2		334

¹ From Ohio Experiment Station Bulletin 245, Minnesota Experiment Station Bulletin 31, and Indiana Experiment Station Bulletin 162.

The use of a small quantity of protein-rich concentrate increased the daily gains 30 per cent and made a saving of 57 pounds of concentrates and 114 pounds of roughage per 100 pounds gain.

LINSEED MEAL AND COTTONSEED MEAL FOR FATTENING SHEEP.**TABLE 8.**—*Summaries of sheep-fattening experiments showing comparative value of linseed meal and cottonseed meal.*¹

Ration.	Initial weight.	Daily gain.	Feed for 100 pounds gain.	
			Concentrates.	Hay.
Ohio station, 112-day trial:				
Lot 1. 40 lambs—				
Linseed meal.....	Pounds. 0.2	65	0.30	397
Shelled corn.....	1.0			
Clover or alfalfa hay.....	1.5			
Lot 2. 40 lambs—				
Cottonseed meal.....	0.2	67	.31	388
Shelled corn.....	1.0			
Clover or alfalfa hay.....	1.5			
Missouri station, 98-day trial:				
Lot 1. 20 yearling wethers—				
Linseed meal.....	0.2	79	.25	491
Shelled corn.....	1.1			
Clover hay.....	1.8			
Lot 2. 20 yearling wethers—				
Cottonseed meal.....	0.2	78	.24	511
Shelled corn.....	1.1			
Clover hay.....	1.8			

¹ From Ohio Experiment Station Bulletin 179 and Missouri Experiment Station Bulletin 115.

In the trials listed in Table 8 cottonseed meal and linseed meal showed substantially the same value for balancing the rations of fattening lambs and wethers. Whether to use cottonseed or linseed meal as a protein supplement for fattening sheep depends to a very large extent upon their relative prices and availability.



U. S. DEPARTMENT OF
AGRICULTURE
FARMERS' BULLETIN No. 1179

FEEDING
COTTONSEED
PRODUCTS
TO LIVESTOCK



IN REGIONS where much corn, stover, fodder, timothy, or other carbohydrate feed is used, it is important to use some feed that is high in protein, such as cottonseed meal.

Cottonseed meal stimulates the appetite of fattening animals and causes them to consume more feed and likewise to make greater gains.

Cottonseed cake or meal may be used satisfactorily as a supplemental feed for fattening beef cattle on pasture.

Cottonseed meal is a very valuable protein feed for dairy cows. One pound of good-quality cottonseed meal furnishes as much digestible protein as 3 pounds of wheat bran. Like wheat bran, cottonseed meal is high in phosphorus.

For high-producing dairy cows, however, the addition of cottonseed meal to rations of the type mentioned renders them satisfactory only so far as the protein requirement is concerned.

Hogs may be fed cottonseed meal in limited quantities as a protein supplement.

Horses may be fed cottonseed products only in small quantities and then with great caution.

Procure prices on various grades of cottonseed meal or cake and choose the feed which supplies a pound of protein at the least cost.

FEEDING COTTONSEED PRODUCTS TO LIVESTOCK

By E. W. SHEETS, *Chief*, and E. H. THOMPSON, *formerly Junior Animal Husbandman, Animal Husbandry Division, Bureau of Animal Industry*

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VALUE OF COTTONSEED PRODUCTS AS LIVESTOCK FEEDS

COTTONSEED PRODUCTS have been used extensively for stock feeding in the South for many years. During more recent times their use has become general in many sections outside the Cotton Belt. The demand from foreign countries is strong, despite the fact that these products cost considerably more there than they do in this country. European feeders, as a rule, have placed more value on high-protein feeds than the average American livestock man.

Another reason why cottonseed products are of such great importance, in addition to their high protein content, is their immense production. Although the production of cotton has shown a slight decrease during the last 10 years, the decrease has not been so marked as has been the case with flaxseed, from which linseed meal¹ is made. Several new protein feeds, like peanut cake, copra cake, and fish meal, have been offered on the market during the last few years, but with the average stockman they have not been received with so much favor as cottonseed meal or linseed meal, due in part to their unknown value. These newer products, however, have some characteristics that are making them of value in livestock feeding.

COMPOSITION OF COTTONSEED PRODUCTS

There are a large number of cottonseed products used as livestock feeds. Both concentrates and roughages are included. All the concentrate products have the same general characteristics and qualities, their chemical composition depending mainly upon the form of manufacture and the thoroughness in separating out the hulls. Among the more common cottonseed products used as feeds are cot-

¹ This product is also known as "oil meal," and "new-process" and "old-process" meal.

tonseed, cottonseed meal and cake, and cottonseed hulls. Table 1 gives analyses representing these products, which have been put on the market by manufacturers to conform to the definitions adopted by the Association of Feed Control Officials of the United States.

TABLE 1.—*Composition of cottonseed products*¹

[Pounds of nutrients in 100 pounds]

Product	Water	Ash	Crude protein	Carbohydrates		Fat (ether extract)
				Fiber	Nitrogen-free extract	
	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
Cottonseed.....	9.1	4.0	19.6	18.9	28.3	20.1
Cottonseed meal and cake:						
41 per cent protein.....	7.1	5.7	41.7	10.0	28.4	7.1
38.6 per cent protein.....	6.9	5.9	38.8	12.2	29.4	6.8
36 per cent protein.....	7.3	5.8	36.8	13.5	30.0	6.6
Cold-pressed cottonseed.....	6.9	4.2	27.5	24.2	30.2	7.0
Cottonseed hulls.....	8.7	2.6	3.5	46.2	38.0	1.0

¹ Furnished by the Bureau of Chemistry, United States Department of Agriculture.

GRADES AND CLASSES OF COTTONSEED PRODUCTS

Formerly cottonseed (uncrushed) was used quite extensively as a feed for livestock. Its value as a source of cottonseed oil and its utilization for commercial purposes has greatly decreased the amount fed in the form of seed. Cottonseed products have taken the place of the seed as a feedstuff. Several feeding tests have indicated that 1 pound of good-quality cottonseed meal is equal to nearly 2 pounds of cottonseed as a feed for fattening steers. Large rations of cottonseed tend to produce scours, but when used in quantities up to 5 or 6 pounds there is little or no trouble from this source.

Cottonseed contains about 20 per cent each of fat or oil and crude protein. Compared with a good grade of cottonseed meal it contains about half as much protein and about three times the content of oil.

A ton of cottonseed will yield approximately the following quantities of products:²

	Pounds
Linters or short fiber.....	110
Hulls.....	514
Cake or meal.....	954
Crude oil.....	303
Dirt and loss in manufacture.....	119
Total.....	2,000

Cottonseed cake is made from the residue which remains after the oil has been extracted from the seed. Ordinarily the greater part of the hulls is removed before the oil is extracted. When this is done the amount of crude fiber in the resulting cake is proportionately smaller. The hulled kernels are crushed, heated, and subjected to great pressure to remove the oil. The residue when of prime quality should be a hard, boardlike cake of a yellowish color. The color is often an indication of the quality. The presence of hulls

² Average for the five years 1914-15 to 1918-19 as compiled by the Bureau of Markets, United States Department of Agriculture, from Bureau of Census figures and estimates.

gives the cake a dark appearance. A dark color may also be caused by overheating during the pressing process or by fermentation, each of which lessens the feeding value.

Cottonseed cake and cottonseed meal are practically one and the same thing; that is, the meal is the cake in a ground form. The meal is most commonly used, but the cake has a distinct advantage in certain cases. European buyers show a preference for the cake for the reasons that there is less loss in handling, it is easier to judge the quality, and because the cake is better adapted for feeding alone or on the ground. Ocean freight rates also are lower for the cake than the meal.

In the United States the cake is preferred by men who feed their cattle in the open where the wind may blow the meal away. On the range or pasture the cake is often broken up and fed in troughs or spread upon the ground. If meal were used, the loss in feeding in this manner would be very large.

There are many grades and classes of cottonseed products sold on the market. The grades as classified and described by the Association of Feed Control Officials of the United States are as follows:

Cottonseed meal is a product of the cottonseed only, composed principally of the kernel with such portion of the hull as is necessary in the manufacture of oil, provided that nothing shall be recognized as cottonseed meal that does not conform to the foregoing definition and that does not contain at least 36 per cent of protein. Cottonseed meal shall be graded and classed as follows:

1. Cottonseed meal, prime quality. Cottonseed meal, prime quality, must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, yellowish, not brown or reddish, free from excessive lint, and shall contain not less than 36 per cent of protein. It shall be designated and sold according to its protein content. Cottonseed meal with 36 per cent of protein shall be termed "36 per cent protein cottonseed meal, prime quality," and higher grades similarly designated (as "43 per cent protein cottonseed meal, prime quality"), etc.
2. Cottonseed meal, off quality. Cottonseed meal not fulfilling the above requirements as to color, odor, and texture shall be graded "36 per cent protein cottonseed meal, off quality," and higher grades similarly designated.

Cottonseed feed is a mixture of cottonseed meal and cottonseed hulls, containing less than 36 per cent of protein.

Cold-pressed cottonseed is the product obtained from the subjection of the whole undecorticated cottonseed to the cold-pressure process for the extraction of oil and includes the entire cottonseed less the oil extracted.

Ground cold-pressed cottonseed is the product obtained by grinding cold-pressed cottonseed.

Cottonseed hulls are the roughage product of cottonseed-oil manufacture. The hulls are removed from the cottonseed before the oil is extracted. They have a very low-protein content and should be fed only in connection with protein-rich feeds. As a roughage the hulls have a lower feeding value than oat straw or corn stover, but are valuable where no other roughage is available. This product is used extensively in the South, especially for steer feeding.

Cottonseed-hull bran is ground cottonseed hulls from which the lint has been removed. The feeding value of the bran is not appreciably greater than that of ordinary cottonseed hulls.

ECONOMY OF USING HIGH-GRADE COTTONSEED PRODUCTS

Cottonseed products containing a high percentage of protein command relatively high prices, but judged from the cost of the protein contained, they are comparatively cheap. Some feeders prefer to buy the lower-grade products, believing them to be more economical

than the better grades. From the standpoint of the cost of the protein in the feeds such men are usually deceiving themselves. These products are usually purchased for their protein content and prices paid should be based on the protein contained in them. To show the value per pound of the protein in feeds at various prices and containing varying guaranteed analyses of protein, Table 2 has been prepared.

TABLE 2.—Cost of protein per pound in feeds at various prices per ton

Cost of feed per ton	Per cent of protein in feeds										
	12	16	20	24	28	32	36	38	41	43	45
	Cost per pound of protein										
	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents
\$25.00	10.42	7.82	6.25	5.23	4.47	3.91	3.47	3.29	3.05	2.91	2.77
30.00	12.50	9.38	7.50	6.25	5.36	4.69	4.16	3.95	3.66	3.48	3.38
35.00	14.58	10.94	8.75	7.29	6.25	5.47	4.86	4.61	4.26	4.07	3.89
40.00	16.67	12.50	10.00	8.33	7.14	6.25	5.55	5.26	4.88	4.65	4.44
45.00	18.75	14.06	11.25	9.38	8.03	7.03	6.25	5.92	5.49	5.23	5.00
50.00	20.83	15.63	12.50	10.42	8.93	7.81	6.94	6.58	6.09	5.81	5.55
55.00	22.91	17.19	13.75	11.46	9.82	8.59	7.64	7.24	6.71	6.40	6.11
60.00	25.00	18.75	15.00	12.50	10.71	9.38	8.33	7.89	7.32	6.97	6.67
65.00	27.08	20.31	16.25	13.54	11.67	10.16	9.03	8.55	7.92	7.56	7.22
70.00	29.16	21.87	17.50	14.58	12.50	10.94	9.72	9.21	8.53	8.14	7.78
75.00	31.25	23.44	18.75	15.62	13.39	11.72	10.41	9.87	9.14	8.72	8.33
80.00	33.33	25.00	20.00	16.67	14.28	12.50	11.11	10.53	9.75	9.32	8.89
85.00	35.41	26.56	21.25	17.71	15.18	13.28	11.80	11.18	10.36	9.86	9.44
90.00	37.50	28.12	22.50	18.75	16.07	14.06	12.50	11.84	10.97	10.48	10.00
95.00	39.58	29.69	23.75	19.79	16.43	14.84	13.19	12.50	11.58	11.04	10.55
100.00	41.67	31.25	25.00	20.83	17.86	15.62	13.89	13.16	12.19	11.63	11.11

The poorer grades of cottonseed meal or cake usually sell only a little lower than the prices for the higher-grade products. By obtaining commercial prices on both high-grade and low-grade products and referring to Table 2, one can ascertain approximately which feed will provide protein at the least cost. It must be remembered, however, that the feeding values of different feeds having essentially the same coefficients of digestibility are not exactly proportional to their respective protein contents. A low-protein feed usually has a higher content of carbohydrates, which may partially make up in feeding value for the difference in protein content.

Good cottonseed meal contains three times as much digestible protein and as much digestible carbohydrates and fat combined as there is in wheat bran. One pound of cottonseed meal will balance as much corn as 3 pounds of bran.

Sometimes the analysis of cottonseed meal offered for sale is given on the tag in terms of nitrogen or of ammonia, or it may be quoted in those terms by feed dealers. One may readily determine the protein content by using the following factors:

Multiply the nitrogen by 6.25. For example, if the analysis is given as 6 per cent nitrogen, then the pounds of protein in 100 pounds of the meal will be 6×6.25 , which is 37.50. This means that it is a good grade of meal.

If the analysis is given in terms of ammonia, multiply the per cent of ammonia by 5.15. For example, if the analysis is given as 7.5 per cent ammonia, the protein in 100 pounds of the meal will be 7.5×5.15 , which is 38.62, meaning that it is a good grade of meal.

COTTONSEED PRODUCTS FOR VARIOUS CLASSES OF LIVESTOCK

The rations given in the succeeding pages may be used as the average and may be adjusted to suit local conditions. If the suggested rations can not be used, one may substitute other feeds of the same general character as those included in the rations outlined. These rations are primarily designed to show the proper proportions in which to use cottonseed products and no attempt is made to cover all conditions.

In discussions of feeding cottonseed products, the quantities for the different classes of animals are given in pounds. While it is important to weigh the meal as fed, yet it may be entirely satisfactory merely to weigh at frequent intervals the contents of a certain measure or vessel. Table 3, giving weights and measures, may be helpful along this line.

TABLE 3.—*Equivalent weights and measures of cottonseed products*

Product	1 quart weighs—	1 pound measures—
	Pounds	Quarts
Cottonseed.....	0.8	1.3
Cottonseed meal.....	1.5	.7
Cottonseed hulls.....	.3	3.3

FATTENING CATTLE

It is for fattening cattle that cottonseed concentrates serve their greatest usefulness. A very large percentage of cottonseed feeds is used for cattle fattened for market. The usual feeding period for this class of cattle is from 90 to 120 days, and during that period comparatively large quantities of cottonseed cake or meal are used. When steers are not fed more than 7 pounds of cottonseed meal a day, they can usually be fed from 100 to 120 days without showing any signs of cottonseed-meal poisoning. If silage or other succulent feed is given as roughage, the meal can be fed longer without harmful results.

When cattle are fed a ration composed only of cottonseed hulls and meal, they usually make good daily gains for the first 60 days, after which the gains diminish rapidly, and after 90 to 100 days they are seldom satisfactory. For a short feeding period cottonseed hulls and meal give satisfactory results. If the roughage is silage instead of hulls, the daily gains are more nearly uniform throughout the feeding period, and if care is used in feeding the meal it can be fed for 150 days without ill effects.

In many of the leading cattle-feeding sections of the Corn Belt cottonseed meal is used extensively, especially as a supplement to silage. (Fig. 1.) Where alfalfa is grown successfully, as in the western part of the Corn Belt, little or no cottonseed meal is used. Not only has it proved to be economical for fattening cattle in the winter, but many feeders use the cake as a supplement to grass. Its use in most feeding sections is limited to 3 or 4 pounds a day for cattle averaging 1,000 pounds live weight.

One reason why cottonseed meal is highly prized for feeding cattle is that it puts on a glossy finish, which makes them sell better than

In many sections of the South there is a shortage of carbohydrate feeds (grains) for fattening purposes, and under these conditions considerable quantities of cottonseed hulls are fed in conjunction with cottonseed meal. This type of ration is more adaptable to cattle 2 years old and over, and for short feeding periods.

Suggested rations for fattening steers averaging 1,000 pounds in weight

RATION 1		RATION 3	
	Pounds		Pounds
Corn or barley (ground).....	20	Kafir or other grain sorghums.....	20
Mixed hay.....	10	Sorgo fodder.....	15
Cottonseed meal.....	3	Cottonseed meal or cake.....	4
RATION 2		RATION 4	
	Pounds		Pounds
Corn.....	18	Molasses.....	3
Mixed hay.....	5	Cottonseed hulls.....	25
Corn silage.....	20	Cottonseed meal.....	7
Cottonseed meal.....	4		

FATTENING CATTLE ON GRASS

Cottonseed products are used liberally as supplements in the fattening of cattle on grass. Cottonseed cake is frequently used as the sole supplemental feed, but more often cottonseed meal or cake is used in a mixture with corn or other grain. A desirable mixture for use as a supplement for cattle on grass is 8 parts by weight of corn or other grain and 2 parts of cottonseed meal or cake. Cattle fattened on grass with a supplement are usually allowed all the feed they will eat once a day in addition to grass. Usually cattle on pasture will not eat more than one-half the feed that would ordinarily be eaten in dry-lot feeding.

STOCK CATTLE

For stock cattle the use of cottonseed meal is ordinarily confined to the winter period, and then only in amounts sufficient to supply the necessary protein. It is especially valuable to use in connection with cheap roughages and silages. For stock cattle weighing from 500 to 750 pounds, from 1 to 2 pounds of the meal is enough to balance most roughage rations properly. If legume hays, such as alfalfa or clover, constitute half or more of the roughage ration, there is little or no need of the use of cottonseed meal.

Few combinations are more economical than a ration of corn silage and cottonseed meal for wintering stock cattle. One to two pounds of cottonseed meal combined with whatever silage stock cattle will eat should keep them in good, thrifty condition and cause them to make a satisfactory gain. The cost of wintering such cattle can usually be lessened by permitting them to run in the stalk fields and giving them feed at night only. Straw and other roughages which can not be used to advantage in any other way may be fed with silage and cottonseed meal.

Suggested rations for wintering stockers averaging 750 pounds in weight

RATION 1		RATION 3	
	Pounds		Pounds
Corn (or sorgo) silage.....	25	Cottonseed hulls.....	15 to 20
Oat or wheat straw.....	Unlimited.	Grass hay.....	5
Cottonseed meal.....	$\frac{1}{4}$ to $1\frac{1}{2}$	Cottonseed meal.....	2

RATION 2		RATION 4	
	Pounds		Pounds
Corn (or sorgo) silage.....	25	Cottonseed cake.....	1 to $1\frac{1}{2}$
Oats or corn.....	2	Silage, to supplement winter	
Cottonseed meal.....	$\frac{1}{4}$	pastures.....	15 to 20
Straw or stover.....	Unlimited.		

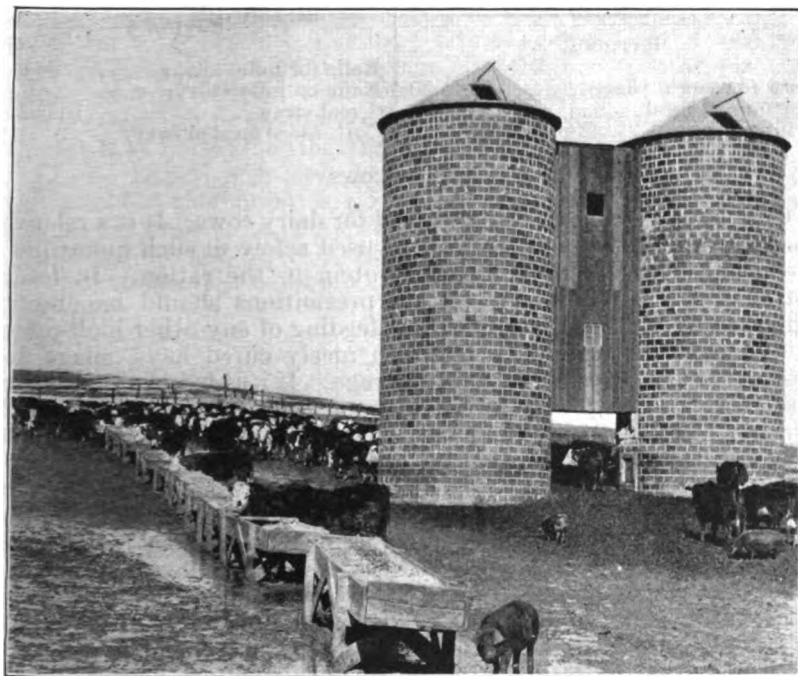


FIGURE 1.—Cottonseed meal and corn silage make a good feed combination for beef cattle. The meal supplies the protein which the silage lacks

BREEDING CATTLE

In feeding cottonseed meal to beef cows, two classifications may be made—dry cows and cows that nurse calves. The dry cows may be handled in much the same manner as stock cattle. The amount of cottonseed meal that should be fed to this class of cows depends on the other feeds used. Some feeders use excessive quantities of cottonseed meal, causing the cost of the ration to become uneconomically high. From 1 to $1\frac{1}{2}$ pounds of cottonseed meal may be fed daily with other feeds, such as corn silage and good hay. Where corn silage is available, a good ration for breeding cows is 25 to 30 pounds silage, from 1 to $1\frac{1}{2}$ pounds cottonseed meal or cake, and other roughage, such as stalks in the field, corn stover, hay, or straw.

Cows that are nursing calves should receive more protein supplements than dry cows, but the amounts fed should not be greater than is necessary to balance properly the other feeds, which may consist largely of roughages. Ordinarily beef cows raising calves are fed not more than 2 pounds each daily, and then only during the winter period.

Suggested rations for wintering beef breeding cows averaging 1,000 pounds in weight

RATION 1		RATION 3	
	Pounds		Pounds
Corn silage.....	25 to 30	Grass hay or stover.....	18 to 20
Cereal straw or stover.....	Unlimited.	Cottonseed meal or cake..	1½ to 2
Cottonseed meal.....	1 to 1½		
RATION 2		RATION 4	
	Pounds		Pounds
Corn (or sorgo) silage.....	25 to 30	Kafir (or milo) silage.....	30 to 35
Cottonseed meal.....	1 to 1½	Kafir or milo stover or ce- real straw.....	Unlimited.
Winter pasture.		Cottonseed meal or cake....	1½

DAIRY COWS

Cottonseed meal is a valuable feed for dairy cows. It is a relatively cheap source of protein, and can be used safely in such quantities as are needed to provide sufficient protein in the ration. In feeding cottonseed meal, however, certain precautions should be observed which apply in large measure to the feeding of any other high-protein concentrate. It should be fed with nicely cured hays, silage, pasture, or other green forage. If it is fed in this way, any reasonable quantity may be fed without injury to the cow. Harmful effects of rations containing cottonseed meal or other high-protein concentrate have been reported only when the roughage fed with the concentrate consisted of cottonseed meal, wheat straw, or other inferior material.

When large quantities of cottonseed meal and a poor roughage are fed to dairy cows, the butter produced is hard, tallowy, and light in color; however, moderate quantities fed with good roughage do not result in butter of undesirable quality. Some kinds of feeds tend to result in a soft butter and the addition of some cottonseed meal to them in the ration results in a butter of satisfactory body.

Suggested rations for a 1,000-pound dairy cow, giving 25 pounds of 4 per cent milk daily

RATION 1		RATION 3	
	Pounds		Pounds
Clover hay.....	10	Barley (or oat) hay.....	15
Corn (or sorgo) silage.....	35	Clover or alfalfa hay.....	5
Ground corn.....	3	Dried beet pulp.....	6
Wheat bran.....	2	Cottonseed meal.....	3
Cottonseed meal.....	2		
RATION 2		RATION 4	
	Pounds		Pounds
Roots (mangels).....	40	Corn (or sorgo) silage.....	35
Mixed hay.....	15	Grass hay.....	10
Corn-and-cob meal.....	3	Corn chops.....	3
Crushed barley.....	3	Cottonseed meal.....	4
Cottonseed meal.....	2½		

BULLS AND YOUNG STOCK

Bulls should receive a liberal quantity of protein-rich feeds. Cottonseed meal or cake may be used for the bull to the extent of from 2 to 4 pounds, with other concentrates, such as bran, corn, and oats.

It is highly important that young stock of both beef and dairy breeds intended for breeding purposes be supplied with an abundance of protein and mineral matter. However, it may not be advisable to feed calves up to 6 months of age more than one-half pound per head per day. Calves at 1 year of age may be fed up to 2½ pounds.

HOGS

Cottonseed meal may be fed safely to hogs to the extent of 9 per cent of the total ration. The most economical method of feeding it, however, is to mix it with tankage, linseed meal, or alfalfa meal, and then not to exceed 50 per cent of such mixture.

Before the use of cottonseed meal became general, cattle feeders believed that hogs following the steers in the feed lot might become poisoned. Experience has shown, however, that no detrimental results follow this practice. Evidently the toxic substances have become neutralized in the process of digestion. When the meal or cake fed to the cattle is not accessible to the pigs, there is no danger that the pigs will be poisoned by eating the waste feed in the droppings.

HORSES

Cottonseed meal may be used as a protein supplement in rations for horses and mules. Its use is recommended only in limited quantities, and then care must be exercised in obtaining cottonseed meal of good quality.

Cottonseed meal has met with some disfavor among horse feeders because they say it causes digestive disorders. There may be considerable truth in this statement, because many horses have been killed by the feeding of excessive quantities of cottonseed meal. In too many cases, however, the quality has not always been the best or the quantity safeguarded. Horses are very susceptible to injury from eating moldy feed, and this applies particularly to the use of cottonseed products. In the South, plantation owners often feed their mules on cottonseed meal in conjunction with corn with apparently good results. Often it is used in connection with black-strap molasses and grain.

The meal should be given to horses gradually at first and it should always be used as a supplement to a carbonaceous feed, such as corn. The meal is not relished by horses and, being unpalatable, it should be well incorporated with other feeds. While it has been fed in larger quantities in a few cases, the best results may be obtained by limiting the amount to from 1 to 1½ pounds per 1,000 pounds live weight and by giving special attention to the horses receiving the cottonseed meal.

Suggested rations for a 1,000-pound horse at medium work

RATION 1		RATION 3	
	Pounds		Pounds
Oats.....	12	Rolled barley.....	10
Timothy hay.....	12	Oat hay.....	12
Cottonseed meal.....	$\frac{1}{4}$	Cottonseed meal.....	1
RATION 2		RATION 4	
Shelled corn (dent).....	8	Shelled corn (dent).....	9
Wheat bran.....	4	Molasses (cane).....	2
Mixed timothy and clover hay.....	10	Cowpea hay.....	6
Cottonseed meal.....	$\frac{1}{4}$	Sorgo fodder.....	6
		Cottonseed meal.....	1

SHEEP

In feeding sheep it is highly important to balance properly the rations used. Protein-rich concentrates can be used advantageously



FIGURE 2.—Best carload of grade lambs from range ewes at the 1925 International Livestock Exposition. Fed and exhibited by Purdue University Agricultural Experiment Station. These lambs received a ration consisting, by weight, of seven parts of corn and one part of cottonseed meal fed with corn silage and clover hay.

for this purpose (fig. 2). Cottonseed meal and cake have been used for fattening sheep with satisfactory results. In limited quantities they have been found one of the best types of protein-rich supplements for sheep.

Cottonseed meal and cake are also used to advantage in limited quantities for breeding ewes. One-half pound a day meets their requirements for a protein-rich concentrate, although these feeds are usually fed in connection with grains, forming from 10 to 15 percent of the grain ration.

Sheep should be started on cottonseed products in small quantities. Lambs when on full feed should receive not more than one-third of a pound a day when fed on other concentrates, and only one-eighth to one-fourth of a pound in combination with other grains. It is advisable to use cottonseed meal in connection with corn, oats, or similar grain. Sheep usually relish cottonseed cake more than the finely ground meal.

Suggested rations for a 60-pound fattening lamb

RATION 1		RATION 3	
	Pounds		Pounds
Shelled corn.....	1.0	Corn silage.....	1.2
Grass hay.....	1.0	Barley.....	1.0
Cottonseed meal.....	.25	Cottonseed meal.....	.2
		Clover hay.....	.6
RATION 2		RATION 4	
	Pounds		Pounds
Shelled corn.....	1.2	Barley.....	.6
Alfalfa.....	.4	Wet beet pulp.....	3.0
Corn silage.....	.6	Cottonseed meal.....	.25
Cottonseed meal.....	.2	Prairie hay.....	1.0

POULTRY

Cottonseed meal is a fair source of protein for diets to be fed to growing chicks, but it should not be used in diets for laying chickens because of the effect it has on yolk color. When large quantities of cottonseed meal—30 per cent or more—are included in the diet of laying hens, most of the eggs will have mottled yolks. When such eggs are stored for a few weeks, the yolks may acquire a brown or chocolate color. Even if as little as 5 per cent of cottonseed meal is fed, mottling and off colors may develop in the yolks after they have been stored a few months.

Although cottonseed meal should not be fed to laying chickens, it may be used to advantage in diets for growing chicks. The following mash diets contain the proper quantities of cottonseed meal.

ALL-MASH STARTING AND GROWING DIET		STARTING AND GROWING MASH WITH WHICH GRAIN IS TO BE FED AFTER THE CHICKS ARE 4 TO 6 WEEKS OLD	
	Pounds		Pounds
Ground yellow corn.....	39.0	Ground yellow corn.....	25.3
Finely ground oats.....	10.0	Finely ground oats.....	10.0
Wheat middlings.....	16.0	Wheat middlings.....	20.0
Dried skim milk.....	10.0	Dried skim milk.....	10.0
Meat-and-bone scrap.....	5.0	Meat-and-bone scrap.....	5.0
Fish meal.....	5.0	Fish meal.....	5.0
Alfalfa leaf meal.....	5.0	Alfalfa leaf meal.....	10.0
Cottonseed meal.....	8.0	Cottonseed meal.....	10.0
Ground limestone.....	1.0	Ground limestone.....	1.7
Salt mixture.....	0.5	Salt mixture.....	1.0
Cod-liver oil.....	0.5	Special steamed bonemeal.....	1.0
		Cod-liver oil.....	1.0
Total.....	100.0	Total.....	100.0

The salt mixture is prepared by mixing 100 parts of salt and 2.2 parts of anhydrous manganous sulphate. If anhydrous manganous sulphate is not available, 3.2 parts of manganous sulphate-tetrahydrate may be used. These mixtures are preferable to salt alone.

The grain to be fed with the above starting and growing mash may consist (1) entirely of corn, (2) of equal parts of corn and wheat, (3) of equal parts of corn, wheat, and oats, (4) of 2 parts of corn and 1 part of oats, or (5) of any other suitable grain or combination of grains.

COTTONSEED MEAL OR CAKE FOR PASTURE FEEDING

For years feeders, of the Southwest particularly, have used from 1 to 2 pounds of cottonseed cake for feeding cows and steers on range.

in the fall and winter. Somewhat more cottonseed cake or some roughage as suggested on pages 6 and 7 should be fed when the grass is covered with snow and also during periods of grass shortage. The fattening of cattle on grass with cottonseed cake during the spring and summer months has been found during more recent years to be an economical practice. The cake is usually preferred to the meal for grass feeding. In regard to feeding cake in preference to meal, a former publication of the bureau is here quoted.³

There are several advantages in feeding cake in place of meal, especially in summer feeding. A rain does not render the cake unpalatable, but it will often put the meal in such a condition that the cattle will not eat it. Again, no loss is incurred with the cake during windy days, whereas the meal, when fed in the open pasture, is sometimes wasted on account of the high winds. Furthermore, the cake requires chewing before being swallowed and therefore must be eaten very much slower than the meal, so when a number of steers are being fed together the greedy one has little chance to get enough cake to produce scours. When cottonseed meal is fed, the greedy steer often scours, because he can bolt the meal and get more than his share; this not only injures the steer but makes the bunch "feed out" unevenly.

In experiments conducted in the Southeast by the Bureau of Animal Industry in which the cake was fed in troughs in the pasture, it was found after several years' work that the feeding of cottonseed cake to cattle on pasture caused the cattle to fatten more rapidly, to develop greater finish, and to make greater profits in most cases than with similar cattle which received pasture alone. The value of the cake as a supplement to pasture, of course, depends to a considerable extent on the nature of the pasture grasses, its use for legumes not being so profitable as with true grasses. As a rule, however, the feeding of cottonseed cake on good grass pasture is not highly profitable. The stage of maturity of the grass is also of significance in this connection, because dry, mature grass is of a more carbonaceous nature than grass in earlier stages of growth.

EXPERIMENTAL RESULTS SHOWING THE VALUE OF COTTONSEED PRODUCTS IN RATIONS

VALUE OF PROTEIN SUPPLEMENT FOR STEER FEEDING

Numerous experiments have conclusively shown the value of protein supplements when added to rations deficient in protein. The following summary covers four experiments, averaging 132 days, with 2-year-old steers, in which a nitrogenous supplement was added to a ration of corn and a carbonaceous roughage.

TABLE 4.—*Summary of four feeding experiments showing the value of a protein supplement*¹

Ration	Number of steers	Average daily gain	Feed per 100 pounds gain		
			Concentrates		Carbonaceous roughage
			Corn	Protein supplement	
		Pounds	Pounds	Pounds	Pounds
Corn and carbonaceous roughage.....	44	1. 60	1, 082	.....	522
Corn, protein supplement, and carbonaceous roughage.....	54	2. 20	766	96	402

¹ Bulletin references: Illinois Experiment Station Bulletin 83; Indiana Experiment Station Bulletin 116; Nebraska Experiment Station Bulletins 90 and 93.

² Bureau of Animal Industry Bulletin 131, Beef Production in Alabama. Out of print.

The addition of the protein supplement increased the average daily gain 0.6 pound a day and reduced the total concentrates required to produce 100 pounds gain from 1,082 pounds to 862 pounds and the roughage from 522 pounds to 402 pounds.

COTTONSEED MEAL COMPARED WITH OTHER CONCENTRATES FOR DAIRY COWS

Many experiment stations have fed cottonseed meal to dairy cows in order to compare it with other protein feeds. A condensed statement of the results obtained is shown in Table 5.

TABLE 5.—*Results of feeding experiments showing relative value of cottonseed meal and other concentrates*

Station	Feed with which compared	Result
Florida.....	Velvetbeans in pod.....	Cottonseed meal worth from 1.5 to 2.5 times as much.
Maine.....	Gluten meal.....	Cottonseed meal superior.
Massachusetts.....	do.....	Do.
Do.....	Ground soybeans.....	Practically the same.
Mississippi.....	Cottonseed.....	Cottonseed meal superior.
Do.....	do.....	1 pound cottonseed meal is equal to 1.71 pounds cottonseed.
Do.....	Velvetbeans in pod.....	3 pounds velvetbeans superior to 2 pounds cottonseed meal.
New Jersey.....	Equal parts wheat bran and dried brewers' grains.	4.5 pounds cottonseed meal are practically equal to 10 pounds of the other feeds.
Do.....	Ground soybeans.....	Practically the same.
Pennsylvania.....	Wheat bran.....	Cottonseed meal increased yield about 20 per cent.
South Carolina.....	Velvetbean meal.....	Cottonseed meal slightly superior.
Do.....	Wheat bran.....	1.5 pounds cottonseed meal slightly superior to 3 pounds wheat bran.
Tennessee.....	Ground soybeans.....	Practically the same.
U. S. Department of Agriculture.....	Fish meal.....	1 pound fish meal is equal to 1.24 pounds cottonseed meal.
Do.....	Peanut feed.....	1 pound cottonseed meal is equal to 1.36 pounds peanut feed.
Do.....	Velvetbean meal.....	1 pound cottonseed meal is equal to 1.54 pounds velvetbean meal.

Cottonseed meal is higher in protein than any other feed with which a comparison was made with the exception of fish meal. It will be noted in Table 5 that in no case did a feed containing a smaller percentage of protein than the cottonseed meal prove to be better than cottonseed meal. In this comparison the only feed showing results superior to those obtained from cottonseed meal was fish meal.

PASTURE SUPPLEMENTED WITH COTTONSEED CAKE

TABLE 6.—*Value of cottonseed products as a supplement to pasture in steer feeding*¹

Lot	Ration	Average daily gain	Concentrates fed daily	Selling price of cattle	Profit per steer
		<i>Pounds</i>	<i>Pounds</i>		
Lot A.....	Pasture alone.....	1.52		\$3.66	\$2.86
Lot B.....	Pasture plus cottonseed cake.....	2.32	3.31	4.53	10.42

¹ From Bureau of Animal Industry Bulletin 131.

The addition of 3.31 pounds of cottonseed cake a day as a supplement to the grass increased the daily gain 0.80 pound, or from 1.52 to 2.32 pounds. The use of the protein supplement increased the selling prices of the cake-fed cattle, so that they made a much greater profit than the cattle receiving grass alone.

**COTTONSEED MEAL AS A SUPPLEMENT TO CORN AND A CARBONACEOUS ROUGH-
AGE FOR FATTENING LAMBS**

In Table 7 the results of four experiments, averaging 80 days, show the effect of adding cottonseed or linseed meal to a ration of timothy hay and corn.

TABLE 7.—Effect of cottonseed meal or linseed meal as a supplement to timothy hay and corn for lambs¹

Ration	Daily gain	Feed for 100 pounds gain	
		Concentrates	Hay
	Pounds	Pounds	Pounds
Corn.....	1.2		
Timothy hay.....	1.0	520	448
Corn.....	1.2		
Timothy hay.....	1.0	463	334
Cottonseed (or linseed) meal.....	.2		

¹ From Ohio Experiment Station Bulletin 245, Minnesota Experiment Station Bulletin 31, and Indiana Experiment Station Bulletin 162.

The use of a small quantity of protein-rich concentrate increased the daily gains 30 per cent and made a saving of 57 pounds of concentrates and 114 pounds of roughage per 100 pounds gain.

LINSEED MEAL AND COTTONSEED MEAL FOR FATTENING SHEEP

TABLE 8.—Summaries of sheep-fattening experiments showing comparative value of linseed meal and cottonseed meal¹

Ration	Initial weight	Daily gain	Feed for 100 pounds gain	
			Concentrates	Hay
	Pounds	Pounds	Pounds	Pounds
Ohio station, 112-day trial:				
Lot 1. 40 lambs—				
Linseed meal.....	0.2			
Shelled corn.....	1.0	65	397	497
Clover or alfalfa hay.....	1.5			
Lot 2. 40 lambs—				
Cottonseed meal.....	0.2			
Shelled corn.....	1.0	67	388	486
Clover or alfalfa hay.....	1.5			
Missouri station, 98-day trial:				
Lot 1. 20 yearling wethers—				
Linseed meal.....	0.2			
Shelled corn.....	1.1	79	491	703
Clover hay.....	1.8			
Lot 2. 20 yearling wethers—				
Cottonseed meal.....	0.2			
Shelled corn.....	1.1	78	511	748
Clover hay.....	1.8			

¹ From Ohio Experiment Station Bulletin 179 and Missouri Experiment Station Bulletin 115.

In the trials listed in Table 8 cottonseed meal and linseed meal showed substantially the same value for balancing the rations of fattening lambs and wethers. Whether to use cottonseed or linseed meal as a protein supplement for fattening sheep depends to a very large extent on their relative prices and availability.

Farmers' Bulletin 1180
United States Department of Agriculture

A 1.9: 1180



HOW TO MAKE HOUSECLEANING simpler and easier and at the same time get full service from the materials used in the furnishing and care of the house, are the problems discussed in this bulletin. The scarcity of labor and the high cost of materials have made these questions increasingly important to the housekeeper. The methods here suggested are based both on the well-tested experience of practical housekeepers and on the results of scientific studies in saving labor in the household. Attempt has been made to explain the reasons behind the methods described and to give definite, concise directions that any one can follow.

Contribution from the States Relations Service

A. C. TRUE, Director

Washington, D. C.

January, 1921

HOUSECLEANING MADE EASIER.

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HOUSECLEANING need not be the bugbear it has long been regarded in many households. If the work is carefully planned, if the kind of furnishings that are easy to keep clean are chosen and handled in the right way, and if provision is made for keeping all the dirt possible out of the house, there will be no need for the upheavals that result in discomfort to the entire household. Moreover, this systematic housecleaning saves labor in the end and is economical of the materials used in the furnishing and care of the house.

Almost every housekeeper has a more or less fixed routine of work, which might be called her plan. Oftentimes, with this plan as a basis, the housecleaning can be so organized that the housekeeper can save herself much time and many steps. In these days, when competent household labor is at a high premium, it is wiser economy than ever to make "the head save the heels."

To keep clean rather than to make clean is a thoroughly practical working principle. This means daily tidying of the rooms in constant use, distributing the cleaning, especially the heavy kinds, through the week, and removing dirt not only frequently but thoroughly by methods that have been proved good according to both scientific and practical standards. All the members of the household can help if only by keeping their own possessions in order and putting things that they use in place in good condition.

What kind of furnishings the house has and how the house itself is arranged and finished have much more effect on the work of house-

cleaning than many persons realize. In many cases just a few changes will soon pay for themselves in time and energy saved. For instance, durable waterproof finish or a covering such as linoleum for the floor in the kitchen and pantry and removable rugs and smoothly finished floors in the rest of the house will prove themselves an economy. Doing away with superfluous shelves and moldings, filling up cracks and crevices in which dirt lodges, and arranging adequate storage places will also help.

Keeping dirt out of the house, or "preventive" housecleaning as it might be called, is well worth the effort. Much dirt is blown in from dusty roads, especially in summer when windows and doors are open, and it is to the housekeeper's interest to see that the roads about her home are oiled or at least regularly sprinkled, either by the community or by the individual residents. When dust can not be laid outside, it can sometimes be stopped at the doors and windows. Removing the dirt regularly from window sills, porches, steps, and walks helps in this, as do also screens covered with cheesecloth or other material through which air will pass, but not dust and soot. Such screens are particularly useful in pantries and storerooms, for doors and windows near the ground against which dirt of all sorts is blown, or in some climates in bedroom windows at night, where they serve the added purpose of keeping out dampness as well as dirt. Muddy or dusty shoes and clothing are another source of dirt in the house. Much of this can be kept out by doing away with dirt walks and bare ground near the house, by insisting that mats and scrapers be used outside the doors, and by providing special places just inside where muddy rubbers and boots and coats may be left.

A good arrangement is to have the men of the household coming in from work or the children from play with dirty, muddy clothes, enter the living rooms of the house through a passageway or small room where they can clean or leave their work clothes or outside wraps. The kitchen is not the room for such cleaning if any other place is available.

IMPLEMENTS AND MATERIALS FOR CLEANING.

No matter how carefully the housecleaning is organized, it can not be done easily and quickly without suitable cleaning tools and materials. The ideal arrangement is to have a complete set stored in orderly fashion in a convenient, well-ventilated closet. Whether few or many kinds are needed, it is economical to buy well-made, durable tools and keep them in good condition and grouped together if possible.

The initial cost of implements of good quality may be a trifle greater than those of poorer grade, but substantial ones gen-

erally give longer and better service and are more economical in the end. Before buying an especially expensive cleaning device or one used only occasionally, such questions as the following should be considered: Will it be used enough to justify the cost? How much care in cleaning and storing will it require? Will it really save time and energy? Will it make some especially disagreeable task less unpleasant? A few well-chosen implements give better service and require less care than a large collection bought haphazard.

TOOLS.

The following list gives some of the desirable cleaning tools and their uses:

Brooms and brushes.—(1) Corn broom for carpets and rough surfaces, such as concrete, brick, and stone.

(2) Soft-hair brush for smooth floors and floor coverings, such as wood, tile, linoleum, oilcloth, and cork carpeting.

(3) Wall brush of lamb's wool, or loops of soft cotton twine, or soft bristles. A bag of cotton flannel slipped over the broom may take the place of a wall brush.

(4) Weighted brush with short bristles for polishing waxed floors. Under no circumstances should this brush be allowed to become oily, but it may also be used in polishing oiled floors if carefully covered with a piece of woollen carpet, heavy flannel, or burlap.

(5) Whisk broom for general use.

(6) Scrub brushes of various sizes for cleaning unfinished wood, sinks, etc. A long-handled one will be found especially convenient for floors (fig. 1).

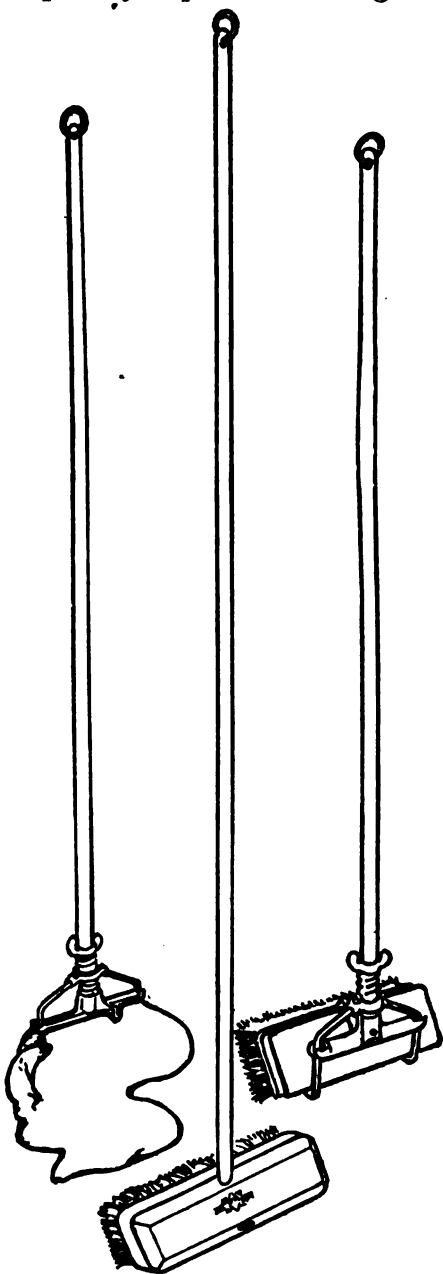


FIG. 1.—Long-handled scrub brushes. These, as well as long-handled mops, save time and effort. The type on the right can be adjusted to hold either a brush or a mop.

- (7) Paint brushes or special brushes of various shapes and sizes for upholstery, reed furniture, and carved surfaces.
- (8) Radiator brush for cleaning between pipes.
- (9) Refrigerator brush, with flexible wire handle, for cleaning drainpipe.
- (10) Long-handled spiral brush or tongs, and prepared soap paper, for cleaning water-closets.



FIG. 2.—Long-handled dustpan. This saves much stooping, and is considered an indispensable piece of equipment by some housekeepers.

Mops.—Wet mop for floors that are to be washed with water. A convenient form has soft, loosely woven cloth fastened to the handle by a flat metal clasp. A mop wringer fastened to a pail saves the worker much stooping, keeps the hands from the water, and removes more water from the cloth than would be possible by hand wringing.

Dry mop either untreated or oiled. The latter holds the dust better and renews the finish on painted, varnished, or shellacked floors, but should not be used on waxed surfaces.

Dustpan.—The edge should be firm and should come in direct contact with the floor, and the side to which the handle is attached should be high enough and so shaped as to prevent dirt from falling out. A long-handled dustpan does away with some stooping and is considered convenient by many (figs. 2 and 3).

Dusters.—A duster should be soft and should shed neither lint nor ravelings; it holds the dust better if dampened or oiled. Silk and chamois are excellent for use on highly polished surfaces. A duster may be moistened by passing it through steam; by wetting one corner of the cloth, rolling it up, and letting it stand for a short time; or by wringing together one dry cloth and one that has been wrung out of water. A dust cloth may be oiled by applying a few drops of kerosene or light lubricating oil on one corner, rolling the cloth, and letting it stand until

the oil has spread evenly. Cotton waste and paper are good substitutes for dust cloths in cleaning dirty, greasy surfaces. Feather dusters should not be used, except perhaps just before sweeping, for they scatter but do not remove dirt.

Carpet sweepers.—Many good kinds are on the market and are effective for taking up surface dirt. A hand-power combination carpet sweeper and vacuum cleaner takes up surface dirt and to some extent sucks up fine particles.

Vacuum cleaners.—All vacuum cleaners suck up fine dust and dirt, and many are now equipped with brushes that take up coarse dirt and lint also. Good ones clean thoroughly and without scattering the dust into the air. They are perhaps most efficient when run by electricity or motor, for in many cases the hand cleaners require two persons to operate them, one to work the handle and the other to direct the nozzle.

Carpet beaters.—These may be of wire or of either flat or round reed. Those of flat reed are least hard on the carpet fibers.

Pails or buckets.—Galvanized iron or fiber pails are light in weight and durable; the former are cheaper.

Besides these tools and a liberal supply of paper and cloths, various materials are used to loosen the dirt and make it easier to remove. All these cleaning materials or agents should be used sparingly. This is not only economical of the cleaners but less likely to injure the surfaces cleaned. Some of those most commonly used are listed below.

MATERIALS.

Water.—This is by far the most common cleaning material. Hot water loosens dirt more easily, but it is more likely to injure finishes and fabrics than lukewarm or cold water. Water should not be allowed to stand on floors or woodwork nor to get into cracks or seams; it should, in fact, be used very sparingly and in most cases wiped off at once.

An abundant supply of water piped through the house and a good drainage system for carrying away waste are of first importance in making housecleaning easier, as well as for the health and general comfort of the household. Simple, inexpensive systems and their installation are described in other bulletins of this series,¹ as are also ways of softening hard water for household use.²

Soap.—This is used to loosen the grease that holds the dirt to fabrics and finishes. A mild soap—that is, one with no free alkali—is less likely to injure finishings and colors than a stronger one. A soap solution makes suds more quickly and cleans more evenly and safely than soap in cake; a quantity may be made at a time, and bits of soap may be used up in this way. One pound of soap and three quarts of water are heated slowly until the soap is dissolved and then the solution is placed in broad-mouthed bottles or jars, for use as

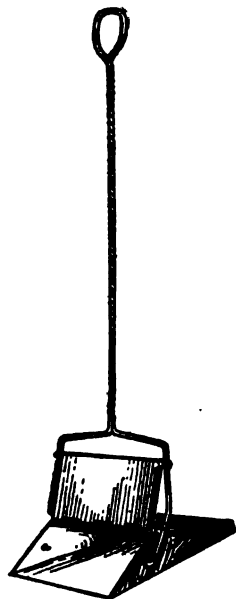


FIG. 3.—Another type of long-handled dustpan. As the pan is lifted it closes automatically, thus preventing the dust swept into it from falling out.

¹ U. S. Dept. Agr., Farmers' Bul. 927, Farm Home Conveniences. U. S. Dept. Agr., Farmers' Bul. 941, Water Systems for Farm Homes.

² U. S. Dept. Agr., Farmers' Bul. 1099, Home Laundering.

needed. Flaked and chipped soaps dissolve more quickly than cake soap. Several kinds are now on the market, and hard cake soap may be chipped at home by being rubbed over a grater.

Soap may be made at home from lye and waste fat, and the directions given on the lye container will generally be found satisfactory. Homemade soaps, however, are likely to contain free alkali and should be used with caution, especially on delicate and colored fabrics, and on paint, varnish, or other finishes.

Ammonia, borax, and sal-soda (washing soda).—These alkalis are used both to soften hard water and to loosen dirt. Concentrated ammonia bought at a drug store and diluted at home by using about 1 part ammonia to 7 parts water is usually more economical and satisfactory for general cleaning than the dilute form sold as household ammonia. Borax is least likely to injure delicate fabrics, but is the most expensive of these three alkalis. Washing soda is bought in coarse powder form and should be thoroughly dissolved in water before using. A bottled "liquid soda" made by boiling 1 pound of soda and 1 quart of water in an old kettle is convenient, but as it has only one-half the strength of dry soda, twice as much must be used in a given amount of water.

Lye, caustic potash, caustic soda.—There is much confusion regarding these materials and their uses. Correctly speaking, lye is caustic potash, but the material sold as lye is almost always caustic soda. Caustic potash may usually be obtained at drug or chemical supply stores. Caustic soda, which is very much cheaper, can be bought (as lye) of almost any grocer. Both are used in soap making, caustic potash in making soft soap, and caustic soda in hard. Both are also occasionally used to dissolve grease in cleaning. They are very injurious to the skin and to most finishes, and must be handled with great care.

Oxalic acid.—This is used to bleach stains on wood and to clean copper and brass. It is usually sold in the form of crystals, 1 ounce of which may be put in an 8-ounce (half pint) bottle of water. This amount of water will not dissolve all the crystals, but to be sure of having a strong (saturated) solution there should be some undissolved crystals. The liquid solution may be poured off as needed and diluted with water to any desired strength. Oxalic acid is a poison and should be so labeled and kept where children can not get at it.

Gasoline and benzine.—These are used to dissolve grease and sometimes to control insects; they are so inflammable and explosive that the fire laws of many States allow only very small quantities to be kept in a house. When either of them is used in cleaning, it should be put in a small bottle and kept well corked, except when the liquid is actually being poured out. The bottle should not be opened in a room in which there is a fire or a gas, oil, or candle flame, or in bright sunshine. Only a little liquid should be poured out at one time.

Kerosene.—This is used to cut grease and loosen dirt, and sometimes to repel insects.

Oils.—Various kinds of oils are used to renew the finish on shellacked, varnished, and oiled surfaces. Cloths moistened with linseed oil are especially liable to spontaneous combustion and should be either destroyed immediately after use or kept in a tightly covered fire-proof container. Light mineral oils, such as are used for lubricating motors, are less dangerous in this respect and are also cheaper than linseed oil. They may be diluted with eight or ten times their volume of kerosene or gasoline. When the latter is used the mixture is, of course, highly inflammable and must be treated as carefully as pure gasoline.

Turpentine.—This is used to dissolve paint, varnish, and wax. It is inflammable and should not be brought near a flame.

Absorbent powders.—These include fuller's earth, French chalk, and corn meal, and are used to absorb grease from fabrics and finishings and to prevent freshly spilled liquids from soaking into fabrics.

Whiting, rouge (peroxid of iron), rottenstone, bath-brick, and pumice.—These abrasives, or frictional agents, are used for scouring tarnish and stains, and for polishing. The different kinds vary in fineness, hardness, and the shape of their particles, and different grades of the same kind vary in fineness. The finer and softer ones, such as fine whiting (Paris white) and rouge, are, of course, least likely to scratch a soft surface and injure a high polish or glaze. Abrasives are mixed with water, oil, soap, acid, or alkali, or whatever combination of these is most effective for a particular purpose. Most commercial polishes are mixtures of this kind.

Steel wool.—This consists of hair-like particles of steel. It is used in scouring certain metals and in removing varnish or paint. Different grades are numbered according to fineness, 00 being the finest. In using it the hands should be protected by old gloves or mittens.

Furniture polish.—This is convenient for rubbing up various kinds of wood-work. The United States Bureau of Standards recommends a simple kind, made by mixing 1 part raw linseed oil with 2 parts turpentine and adding a little melted beeswax if desired. Or a light mineral oil diluted with kerosene or gasoline (see p. 8) may be used for this purpose.

Floor wax.—This is used for giving a polished surface to wood floors. It should be applied in thin coats and well rubbed in with a weighted brush. The United States Bureau of Standards suggests two recipes:*

(1) Mix 1 pint of turpentine and 4 ounces beeswax and heat in a vessel set over hot water until the wax is melted. Remove from the heat. Add 3 ounces aqua ammonia (concentrated ammonia) and about 1 pint of water and stir vigorously until the mass is creamy.

(2) In a vessel set in hot water melt 2 ounces each of carnauba wax and ceresin, then add 3 ounces of turpentine and 12 ounces (about 1 pint) of gasoline; cool as rapidly as possible, stirring vigorously to produce a smooth, creamy wax.

In making both these polishes great care must be taken to heat them only by setting in hot water and to have no open flame in the room, for both gasoline and turpentine are very inflammable.

CARE OF CLEANING IMPLEMENTS.

Time and bother are saved if the cleaning tools and materials are kept together in a convenient place, preferably a special closet located where it can be quickly reached from all over the house (fig. 4). If possible, it is well to have on each floor a supply of some of the things most constantly used. As far as possible, cleaning tools should be put away clean and ready for use.

Brooms, brushes, and mops should be hung by strings or screw-eyes fastened to the handles so that the weight does not rest on the straws, bristles, or strings. Carpet sweepers also should be set so that the weight does not come on the brushes. The hair and lint which accumulate in brushes, especially in carpet sweepers, may be

* U. S. Dept. Commerce, Bu. Standards Circ. 70, Materials for the Household.

taken out with an old buttonhook, a coarse comb, or old scissors. Corn brooms may be washed in hot soapsuds, but care must be taken not to let the water rust the wires which hold the straws to the handle.

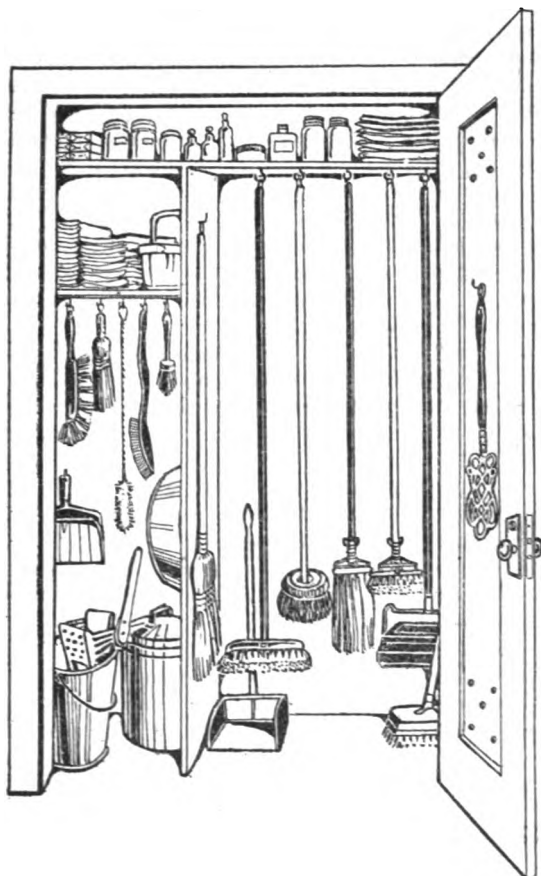


FIG. 4.—A conveniently arranged closet for cleaning tools. Housecleaning can be made easier and done more quickly with good durable tools kept in order in a convenient place. If a built-in closet is not available, a wardrobe of the less expensive kind may be used. In either case ventilation should be provided by holes in the door.

Bristle brushes may be washed with lukewarm water and a little ammonia (3 teaspoons dilute ammonia to the quart) or borax (1 teaspoon to the quart) and then rinsed in clear water. Water is likely to injure the back of a brush and to loosen the cement by which the bristles are held in place in the less expensive makes. The brush should, therefore, not be covered with water, but should be washed by sousing the bristles back and forth in shallow water; it should be dried with the bristles down or with the weight resting on the side of the brush. The drying should be done quickly, but not in an intense heat. Drying in sunshine whitens light bristles. The weighted bristle brush

used in polishing floors should be washed occasionally to prevent the accumulation of dirt and wax from darkening the wood.

Mops may be washed in hot suds and rinsed in clear, hot water; they should be quickly dried. Dry mops may be oiled or oiled ones renewed by pouring a few drops of light lubricating oil or any good floor oil into an old dish or a tin box and setting the mop on this for a day or two; or the mop may be sprinkled with a little oil and allowed to stand until the oil spreads through the strings.

Dust cloths should be washed frequently, both because a little dirt comes out more easily and because dirty ones often leave as much dirt as they take up and may scratch highly polished surfaces.

The heavy woolen cloths used in polishing floors may be soaked for an hour or more in hot water and soda, using 3 tablespoons of soda or half a cup "liquid" soda to a gallon of water, and stirring the cloths occasionally with a stick; then they should be washed in hot soapsuds and finally rinsed in hot water. A little kerosene or light lubricating oil added to this last water will soften the cloths.

The oil in "dustless" cloths may be restored as directed on page 6, or a little oil may be added to the rinsing water, 1 tablespoon of kerosene or one-half tablespoon light lubricating oil being used to a quart of water.

The box of a carpet sweeper should be opened over dampened newspaper, the dirt emptied out, and the brush cleaned. The mechanism should be kept properly oiled. A vacuum carpet sweeper is cleaned in the same way, but, in addition, the bag must be taken off and emptied.

METHODS OF CLEANING.

Frequent cleaning saves time and strength in the long run and is also better for the house and its furnishings, because the fabrics and finishes receive less rubbing and wear. If dust is allowed to remain it may be ground in or covered with a grease film; in either case it will be harder to remove. Moreover, the fine particles of dirt rub against the fabrics and finishes and tend to wear them out. Different kinds of surfaces and furnishings must be treated in different ways to keep them clean and prolong their usefulness.

WALLS AND CEILINGS.

Ordinary plastered and papered walls and ceilings should be cleaned with a wall brush or a broom covered with soft cloth, such as cotton flannel. Light overlapping strokes should be used; heavy strokes rub the dirt in. Cotton batting is good for cleaning places that soil more quickly than the rest, for example, the wall over radiators, registers, and stoves. The wall should be rubbed lightly with the cotton, which should be turned as it becomes soiled.

There are commercial pastes and powders for cleaning wall papers, but, in general, these should be applied only by an expert. An amateur is likely to have a streaked wall if he attempts to use them.

The so-called washable papers used in kitchens and bathrooms may be cleaned with a dampened cloth, but water must be used sparingly; if it seeps in the paper will be loosened. Varnishing the paper in these rooms will make it more nearly impervious to moisture and steam and will prevent it from peeling.

Rough wall coverings, such as burlap, are hard to clean. The dust should be removed by brushing or with a vacuum cleaner.

Some painted walls may be washed, but as in the case of all painted surfaces the success with which this may be done depends largely on the kind and quality of the paint. In the case of ordinary oil paint, the wall should be rubbed with even strokes, using a cloth wrung out of light suds, then rinsed with a cloth wrung out of clear water, and wiped with a dry, soft cloth. If the paint is badly soiled and stained, a fine scourer, such as whiting, may be used.

Enamel paint (that is, paint mixed with varnish, which gives a hard, smooth surface and does not catch or hold dust so easily) is dulled by soap. Such paint may be cleaned by rubbing first with a woolen or cotton flannel cloth wrung out of hot water, and then with a clean, dry cloth. Spots, stains, and dirt that will not yield to hot water alone may be removed with a fine scourer, but it must be applied lightly in order not to scratch the surface.

Calcimined walls can not be washed nor can they even be rubbed with a dry cloth without streaking the finish. Recoating is for this reason preferable to cleaning.

Tiling may be cleaned by washing with warm, soapy water, rinsing, and drying thoroughly; or, when necessary, a fine scourer may be used. If water is allowed to remain on tiling it is likely to injure cement of the kind in which the tiles are set and thus to loosen them. The wall finish known as metal tiling may be cleaned in the same way as paint.

Cement walls and floors may be washed by flushing with a hose, by scrubbing, or by mopping. Moisture makes cement of this kind slippery, but does not injure it. Cement floors are usually equipped with a drain, and if properly laid the floor slants toward the drain, so that water runs off.

WOOD SURFACES.

Unfinished wood surfaces absorb grease and dirt more readily, are more likely to stain, and are harder to keep clean than those in which the pores of the wood are filled with varnish, oil, paint, or other finish. In general, a house should contain as few unfinished wood surfaces as possible. In the kitchen, for example, labor may be saved by finishing or covering the floor, by covering the table with oilcloth, linoleum, or zinc, and by painting or varnishing the rest of the furniture. Unfinished wood surfaces may be scrubbed with the grain of the wood, using small quantities of water and a mild soap, rinsed with a cloth wrung out of clean water, and wiped dry. Strong soaps, alkalis, and too much water darken wood and may soften it.

If the dirt can not be removed with soap and water, a scourer, such as fine steel-wool or powdered pumice, may be used. Unfinished

wood can be bleached with oxalic-acid solution, which is poisonous (see p. 8). The wood should be covered thinly with the solution, allowed to dry, and then thoroughly washed until all traces of the acid are removed. If grease is spilled on unfinished wood cold water should be applied at once, if possible, in order to harden the grease and prevent its spreading, then as much grease as possible should be scraped off with a knife, and the spot scrubbed with a washing soda or lye solution. If the spot appears dark, a paste made of fuller's earth and water should be spread over it and allowed to remain overnight.

Oiled floors should be swept with a soft brush and dusted with a dry or oiled mop. Occasionally they may be washed and afterwards wiped with an oily cloth. Water should be used sparingly, and care should be taken to rub the oil in well and not to use so much that a surplus is left on the surface to hold dust and be tracked onto rugs.

Varnished and shellacked surfaces should ordinarily be dusted clean with a soft brush or cloth and polished with an oiled mop or soft cloth moistened with a few drops of light lubricating oil, lemon oil, or furniture polish. The oil or polish should be well rubbed in and any surplus removed with a soft cloth. In general, varnished and shellacked surfaces should not be touched with water. However, if badly soiled they may be wiped with a cloth wrung out of warm, slightly soapy water, wiped dry at once, and then polished with oil. The appearance of badly worn varnished woodwork may be improved by rubbing it with a good grade of floor wax.

Waxed surfaces may be cleaned with a soft dry duster, or in the case of floors a soft brush or a mop free from oil. The film of dirt and wax which darkens the surface may be removed with a cloth wrung out of warm, soapy water, or, better, with one moistened with turpentine or gasoline; the latter method brightens as well as cleans the surface, whereas water dulls and whitens wax. Both turpentine and gasoline are highly inflammable and should never be used in a room where there is a fire or a lighted lamp or candle (see p. 8). If a waxed surface has been dulled by water, the luster and color may be restored by rubbing with a warm woolen cloth or a weighted brush. Many spots on waxed surfaces may be removed by rubbing with a little turpentine and refinishing with a little wax; iron rust and ink stains may be bleached out with oxalic-acid solution (p. 8) as from unfinished wood. After all traces of the acid have been washed off and the spot is thoroughly dry, it should be rewaxed and polished.

If a floor needs rewaxing, it should be thoroughly dusted, washed, or preferably rubbed bright with a cloth moistened with turpentine or gasoline, and given a thin, even coating of liquid or melted wax rubbed in lengthwise of the grain of the wood, first with a soft cloth and then with a weighted brush. When the wax is well rubbed in

the brush should be covered with a piece of heavy material, such as carpet or burlap, and the floor polished until it has the desired luster.

Painted woodwork should, as far as possible, be kept clean by dusting rather than by washing, since the latter is harder to do and wears the paint much more rapidly. When washing becomes necessary it should be carefully done. It pays to wipe off dirt, such as that around door knobs, as soon as it appears.

FLOOR COVERINGS.

For the daily care of woolen or cotton carpets and rugs a carpet sweeper is the best tool, because it takes up lint and coarse dirt without raising dust. For more thorough cleaning some other tool must be used, as the brushes of the carpet sweeper do not go deep enough into the carpet to remove fine dirt. A vacuum cleaner is excellent, but if that is not available effort should be made to find some other thorough but comparatively dustless process. Using a dampened broom and scattering left-over tea leaves, bits of rumpled, dampened newspaper, or one of the commercial sweeping preparations on the carpet before sweeping helps to prevent dust from flying. These dampened materials must be used with caution, however, or stains will result, especially on delicately colored carpets. Wiping a carpet with a dampened cloth after sweeping removes more dust and freshens the carpet.

Small rugs should be cleaned out of doors, if possible, preferably on the dry grass or dry snow. They should be placed right side down, beaten with a flat carpet beater, swept, turned over, and swept again. Hanging rugs over a line while they are being cleaned, or holding them by the corners and shaking them, strains them badly; it may break the threads or loosen the bindings and cause the ends to ravel.

Practically all rugs, after thorough beating, may be cleaned with soap and water. Rag rugs may be washed like any other heavy material, but they must be thoroughly rinsed. Sometimes it is easier to rinse a heavy, wet rug with a hose than in a tub. Other rugs can be placed on a table and scrubbed with a brush and mild soapsuds. As each section is cleaned it should be rinsed thoroughly, and the water should be changed as it becomes discolored. Rugs washed by this method are clean, but they may shrink and lose their shape and the colors may fade and run. Oriental rugs with very long, thick pile should not be thus cleaned unless they can be dried quickly and thoroughly; if moisture remains in the depth of the pile, it may rot the threads.

Fine, smooth mattings should be swept with a soft brush and dusted with a dry mop, or if necessary, they may be washed with a

cloth wrung tightly out of warm water and wiped dry with another cloth. A carpet sweeper may be used on the heavier grass and fiber floor coverings. All grass and fiber floor coverings should be taken up occasionally to remove the dirt which sifts through in spite of frequent cleaning.

For the daily care of linoleum, floor oilcloth, and cork carpeting an oiled mop or soft brush may be used. When very dirty they may be washed with warm water and mild soap, rinsed, and wiped dry. Only a small space should be wet at a time, and care should be taken to prevent the water from getting underneath. Scrubbing linoleum, using strong soaps or powders that contain alkali, or using too much water will ruin linoleum in a short time.

FURNITURE.

Dusting furniture thoroughly and often helps to keep it in good condition. In addition, the woodwork should be rubbed occasionally with furniture polish (see p. 9), or wax, or oil, according to the original finish, and only soft dusters, free from gritty substances, should be used. Silk and chamois are excellent because they leave no lint.

The varnish on some furniture is so hard and smooth that finger marks and such soiled places may be removed with a cloth wrung out of lukewarm suds made with neutral soap, and the finish restored by rubbing with a cloth on which a few drops of light lubricating oil or furniture polish have been sprinkled. In many cases this is a good method to use on the tops of dining tables, but in general it is unwise to put water on varnished, oiled, or waxed surfaces. Painted and enameled furniture may, of course, be washed like any other surface so finished (p. 14).

For upholstery, either a vacuum cleaner or a brush is the most effective tool. A soft brush is best for velvet and velour, a stiffer one for tapestry and other strong, firm materials, and a pointed one for tufted upholstery. If convenient, upholstered furniture should be taken out of doors occasionally and beaten with a flat carpet beater, or it may be cleaned indoors by the following method. The article to be cleaned is first covered with a cloth that has been dipped in water and wrung as dry as possible, then beaten with a flat beater, the dust being taken up by the damp cloth.

Leather furniture coverings last longer and look better if rubbed occasionally with castor oil or a commercial leather polish to restore the oil that gradually dries out. The liquid should be well rubbed in and any excess wiped off the surface; otherwise this film of oil will collect and hold dirt which will darken the leather and soil whatever touches it.

The crevices in wicker furniture are difficult to clean, but fortunately dirt does not cling to it as to upholstery. Brushing followed by dusting seems to be the best treatment.

WINDOWS AND MIRRORS.

Daily or at least frequent dusting of windows and mirrors keeps the glass clean and bright a long time without special cleaning. When more thoroughgoing treatment is necessary, either liquid or dry cleaners may be used.

The most common liquid cleaners are clear water or water to which washing soda, borax, ammonia, kerosene, or alcohol has been added. Clear alcohol is excellent for use in cold weather, because it does not freeze, but it is too expensive for ordinary use. Soap should be used in a very light suds, if at all, for it is likely to leave a film on the glass. With liquid cleaners good results depend quite as much upon the method of application as upon the cleaner itself. The best general method is to dip a cloth in the liquid and wring it as dry as possible; then, to wash the glass with this cloth, using even overlapping strokes, and dry it by rubbing briskly with paper, cloth, or chamois. If the liquid dries without rubbing, especially if it has been put on freely, the window will be streaked. A quick method, particularly adapted to large windows, is to use water freely and wipe it off with a rubber "squeegee" drawn smoothly and evenly across the pane with overlapping strokes. Special care must be taken to protect the woodwork from the water.

For dry cleaning, whiting or a commercial powder of the same fineness is used. The powder is made into a paste with water or alcohol, applied thinly to the glass, allowed to dry thoroughly, and then rubbed off with a soft cloth or paper. This is an easy method of obtaining clear windows and is especially good to use in winter, as the moisture evaporates before it freezes. It is also a good way of cleaning mirrors, picture glass, and the like, which might be injured by water. It is, however, a dusty process and should be used before cleaning a room.

Paint or varnish spatters on glass may be dissolved with turpentine or alcohol or rubbed off with a dull knife.

CHINA, EARTHENWARE, AND GLASSWARE.

Dishes and ornaments made of these materials are usually cleaned by washing in hot water and soap, rinsing in clean hot water, and either wiping dry with a clean cloth or draining dry in a place free from dust. They should never be quickly heated or cooled, because sudden changes of temperature are likely to crack them. Special care must be taken with glass to have the last water clean and the

cloth both clean and free from lint. Strong soap or soap powder should not be used on articles decorated with gilt, because these cleaning materials may contain chlorin, which is injurious to gilt. Alkalis may sometimes affect other colors. Even the most careful washing will gradually wear off many kinds of colored decoration, especially those in gilt. Hard rubbing and long soaking and the use of any cleaning agent, except water and suds of mild soap, should, therefore, be avoided in the case of choice pieces.

Deeply cut glass may be scrubbed with a small brush and soapy water or water containing a little ammonia, and then rinsed in clear water, and rubbed dry. The inside of vases and bottles may be scoured by shaking a little bird shot or a few small, hard buttons and soapy water about in them, or by the use of special bottle brushes.

Bric-a-brac and dishes so shaped that parts can not be easily reached often add unnecessarily to the work of cleaning.

SILVER.

The tarnish on metals is due to the action on the metal of moisture, air, food, or other substances. Different metals are affected by different substances.

The tarnish on silver is silver sulphid and is due to the sulphur compounds in the air where coal and gas are burned, also in many foods, in wool, in rubber, and in some bleached and dyed materials. This is the reason silversmiths avoid white cotton flannel for their cases for silver. Dryness prevents tarnishing somewhat, and so camphor, which absorbs moisture, is sometimes put into the silver drawer. Silver may be cleaned by the use of frictional agents, by boiling it in a strong alkaline solution, or by electrolysis.

The frictional materials used are fine whiting, rouge, and commercial pastes or powders. The noncommercial powders are mixed

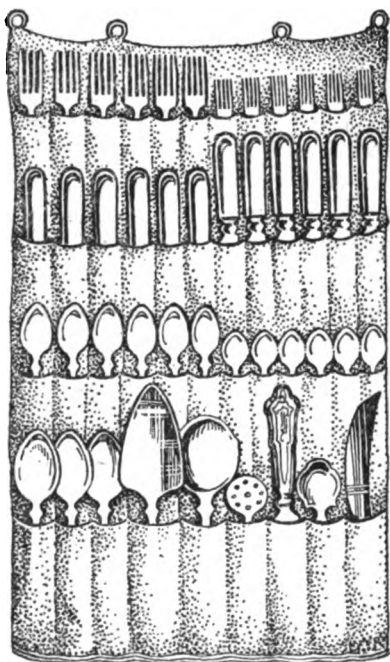


FIG. 5.—Case for silver. A case of this sort made of red or gray cotton flannel and hung on the wall or door of a cupboard in or near the dining room is very convenient for silver in every-day use. The pieces of silver can not rub against each other as they do when placed together in a drawer or box, and it is possible to tell at a glance whether any are missing.

to a paste with water, ammonia, or alcohol, applied to the silver, allowed to dry, and then rubbed off with a soft cloth, chamois, or a brush. The result is bright, lustrous silver. Prepared cloths, sold under various trade names, also clean by friction. They are usually cotton flannel treated with a cleaning mixture, and are convenient but relatively expensive.

The alkaline solution for cleaning silver is made by dissolving 4 teaspoons of borax, 3 teaspoons washing soda, or 2 teaspoons lye (caustic soda) in 1 quart water. The silver is placed in an old kettle or pan, covered with this solution, boiled for 10 minutes, and cooled in the water.

One method of removing the tarnish from silver by electrolysis is the following: Fill an enameled or agateware kettle partly full of water in which has been dissolved 1 teaspoon of either washing soda or baking soda and 1 teaspoon salt to each quart of water, heat this solution to the boiling point, put in strips of aluminum or bright zinc, add the tarnished silver, and boil it. The silver must be covered completely by the water and each piece must be in contact with the zinc, either directly or through other silver. When the tarnish has disappeared, the silver should be removed from the kettle, washed, and dried with a clean, soft cloth. An aluminum kettle may be used, but it soon corrodes and must be cleaned, as only a clean, bright kettle serves the purpose. The zinc also grows dull and then is less active; it may be cleaned in water containing a little hydrochloric (muriatic) acid, which is very poisonous and must be handled with extreme care. Various commercial devices for cleaning silver by electrolysis are on the market and may be used in place of the zinc or aluminum strips.

Silver cleaned either in an alkaline solution or by electrolysis lacks luster, which cleaning by friction gives. It may be made bright, however, by a little rubbing.

COPPER, BRASS, AND BRONZE.

The tarnish on copper, brass, and bronze is copper carbonate. It may be removed by friction, or it may be dissolved in weak acids.

Rottenstone mixed with oil to a creamy consistency is the common frictional agent used on these metals. After this cleaner has been applied, the metal should be polished with a soft cloth. A final rubbing with dry rottenstone or whiting will give the metal an even brighter luster.

Oxalic-acid solution, buttermilk, or vinegar, especially when warmed, quickly dissolves the tarnish on these metals. All traces of these cleaning agents must be removed, however, or the metal will tarnish again very quickly. Washing the metal in water, drying it,

and rubbing it with dry whiting is the best way to remove the acid. The whiting not only takes up moisture but gives the metal a brighter luster than when acid alone is used.

ALUMINUM.

Aluminum does not tarnish easily in ordinary use, but one precaution should be observed in cleaning. Alkalis discolor aluminum; therefore it should not be washed with strong soap, nor should scouring powders containing free alkali be used on it. Discoloration on aluminum may be rubbed off with whiting or fine steel wool (grade 00) or dissolved by the acid of vinegar or by dilute oxalic acid (see p. 8). These acids must be thoroughly washed off the aluminum. Some special preparations for cleaning aluminum are on the market.

NICKEL.

Nickel and nickel-plated articles do not tarnish so readily as silver. Washing them frequently with hot soapy water and drying them with soft cloth or paper will usually keep them in good condition. Whiting or some other fine scourer may sometimes be used to brighten nickel that has become dull, but such a condition often means that the surface is scratched or the plating broken. Replating is the only remedy in such cases.

IRON AND STEEL.

The rust on iron and steel is different from the tarnish on other metals in that it flakes off, thus exposing another surface to the action of the air and moisture. If this process of oxidation continues long enough, the metal may be eaten away entirely, or "rust out," as is commonly said. Keeping iron and steel dry and brightly polished is the best preventive against rust. If such articles are to be stored, coating the surface with paraffin or other fat that contains no salt or wrapping them in newspaper prevents rust. A scourer, such as bath-brick, applied with a moistened cork or cloth, usually removes rust and discoloration. If this treatment is not effective, kerosene should be poured on the spot and allowed to stand for a few minutes before the scourer is applied. After the rust is removed, all traces of the kerosene should be washed off with hot soapy water and the metal dried thoroughly. Steel wool or a tinsel scrub cloth is also good for scouring rusty iron skillets or kettles. Iron kitchen utensils are smoother and are thought to wear better if they are rubbed with fat and baked before they are first used.

Galvanized iron is iron covered with zinc and does not rust nor tarnish. It is very durable and is extensively used for water pails, garbage cans, and other utensils that receive hard usage. The only

care that galvanized iron requires is washing in hot soapsuds or a weak soda solution, rinsing, and drying:

TIN.

For ordinary care, tin utensils should be washed in hot soapy water, rinsed in hot clear water, and dried thoroughly. A tin utensil that has food dried on it should be covered with a weak soda solution, heated for a few minutes, and then washed. Scraping scratches tin and may expose the iron or steel surface underneath, which may rust. Tin darkens with use and this tarnish protects the tin; therefore tin utensils should not be scoured simply for the sake of making them bright.

ZINC.

Zinc darkens with use, but may be brightened by the use of scourers. Zinc on floors, under stoves, and in like places should be scoured with bath-brick and kerosene, washed and rinsed with water, and wiped dry. Zinc on tables, or wherever likely to come in contact with food, should be scoured with bath-brick and water. Acid, as in vinegar or lemon juice, may be used to remove stains on zinc, but should be thoroughly washed off; otherwise the zinc will tarnish again very soon.

PEWTER, BRITANNIA WARE, AND GERMAN SILVER.

All these metals are soft, and only very fine scourers, such as fine whiting, rouge, or fine rottenstone mixed with oil, should be used on them.

LACQUERED METALS.

Lacquered metals do not tarnish, for the metal is protected from the action of air and moisture by a shellac preparation. Metals treated in this way need only to be dusted frequently, and occasionally wiped with a cloth wrung out of warm soapy water and thoroughly dried. If the lacquer cracks, the only remedy is to remove it with alcohol and relacquer the exposed surface.

ENAMELED WARE AND AGATEWARE.

Enameled ware and agateware are made by coating iron or steel with enamel or glaze. The durability of enameled ware depends on the quality of both the foundation and the enamel and on the care given it. If the foundation is not firm, it will bend with use and the brittle enamel will crack and flake off, for example, as often happens on enameled spoons. Enameled ware should be protected from acids, from sudden changes of temperature, and from unnecessary knocks or blows. An enameled-ware kettle that has food stuck on it should

not be scraped, but should be boiled with a little soda, washed in hot soapy water, rinsed, and dried thoroughly. If this method is not effective, the dish may be scoured with fine whiting or rottenstone.

PLUMBING.

Stoppage in pipes is often due to hardened grease or to an accumulation of hair and lint. The waste pipe leading from a plumbing fixture should be thoroughly flushed after using in order to carry the waste out of the house pipes and leave the trap full of clean water. A trap in a waste pipe is a curved section so arranged that water remains in it and forms a seal that prevents the passage of sewer gas into the house. If the water left in the trap is not clean, decomposition may take place and odors and gases may come from the impurities in the water itself. Precautions should be taken to prevent oil and grease from going down the waste pipe from the kitchen sink, because being lighter than water they tend to remain floating on the surface of the water in the trap.

Occasionally more than cold or even hot water is necessary to clear out the accumulated grease, lint, miscellaneous dirt, and bits of refuse. Washing soda is ordinarily sufficiently strong for bathroom pipes and may be used in the proportion of 1 part "liquid" soda (see p. 8) to 12 parts hot water, or 1 pound of dry soda thoroughly dissolved in 3 gallons of boiling water. The drainpipe from the kitchen sink may sometimes need a stronger cleanser, even if it is thoroughly cleaned and flushed after each dishwashing, and for this purpose caustic potash is efficacious but must be carefully used. The hands must be protected from it, and it must not be allowed to touch porcelain or porcelain-lined sinks, because it may destroy the glaze. One pound of crystals dissolved in 2 quarts of water by stirring with a wooden stick should be poured down the drain. About half an hour later the pipe should be flushed with clear water. Caustic soda, although sometimes recommended, is not suitable for this purpose, because it is likely to unite with the grease and form a hard soap which is difficult to remove from the pipes.

Fine scourers may be used on all fixtures. For porcelain and enameled iron fixtures, kerosene and whiting are especially good; the kerosene cuts the grease, and the whiting supplies the abrasion. Some of the commercial cleaning preparations used for enameled and porcelain fixtures contain scourers so gritty that they scratch the surface and thus make it harder and harder to keep clean. Nothing coarser than whiting should be allowed.

Bathroom fixtures should be cleaned daily. Tubs and bowls should be scrubbed with a fine scourer or with water containing a little kerosene, rinsed with clear hot water, and wiped dry. The stains made by

water containing an excess of iron may be removed from porcelain or porcelain-lined tubs and bowls with oxalic-acid solution, which is a poison and must be entirely washed off. The overflow pipes should be flushed occasionally with hot water, for dirt and grease are likely to collect and decompose there.

The water-closet should be kept scrupulously clean. It should usually be cleaned daily or more frequently if it gets very hard use. The bowl should be flushed, washed with hot soapsuds or soda solution and a long-handled brush, and flushed again. Then the seat, the cover, the chain, and the handle should be washed and wiped. All cloths and utensils used in cleaning the bathroom should be scalded and dried, preferably in the open air.

The crust of lime which is sometimes deposited by hard water can be removed from porcelain and porcelain-lined fixtures with hydrochloric acid. This acid is very poisonous and is also injurious to the skin and to many materials, including the metals used in plumbing, and it must be handled with extreme care. Gloves should be worn when using it. To clean the bowl of a closet, bail out as much water as possible, pour in about a pint of commercial hydrochloric acid (sometimes called muriatic acid) and let this stand for several hours, or until the crust begins to crumble when poked with a stick. Then flush with a large quantity of water. The water in the tank is not enough; more must be poured in by hand in order to dilute the acid and carry it rapidly away. In a porcelain-lined sink or bath-tub the acid must not be allowed to stand on the soiled earthenware because it may get through to the metal underneath and eat that away. It must, therefore, be applied drop by drop to the lime and flushed out with plenty of water as soon as the crust begins to crumble when pressed.

REFRIGERATORS AND FOOD RECEPTACLES.

So far as possible refrigerators should be kept clean by preventive care. Ice should be washed before it is put into the ice compartment. Food should be put into the refrigerator in clean and usually covered dishes and should never be put in hot. Anything spilled in the refrigerator should be wiped up immediately. The contents of the refrigerator should be frequently inspected to make sure that no spoiled food is left in it.

About once a week and at a time when the refrigerator contains only a little ice, it should be thoroughly cleaned. The ice and all the food should be removed. The racks should be taken out, washed in hot water containing soap or soda, rinsed, and wiped dry. If possible, the drainpipe should be removed, scrubbed inside with a long-handled spiral brush or swab, and scalded. If the pipe is not removable, it should nevertheless be thoroughly cleaned out, for it

may contain not only solid matter from the melting ice, but also slime formed by the organisms that thrive in such a dark, cool, moist situation. The small trap in the drainpipe should also be cleaned, and the drain pan should be washed and scalded. The inside of the refrigerator should be washed with hot water containing soap or soda, rinsed, and dried thoroughly. A small pointed stick like a skewer should be used to clean the corners and seams.

So-called "iceless" refrigerators should be cleaned as regularly as those of the ice-box type. The shelves should be washed and sunned, and, if possible, two sets of curtains should be provided so that each can be washed and sunned every other week. Food safes, bread boxes, and other receptacles for food should likewise be regularly washed, scalded, and aired to prevent mold and decay of their contents.

STOVES.

The outside of all stoves should be wiped frequently with a cloth, soft paper, or cotton waste. Grease may be washed off with soap and water. Rubbing the stove with a soft, thick cloth moistened with a few drops of kerosene or light lubricating oil will keep it in good condition, though not polished. For cookstoves especially, many housekeepers consider this sufficient and prefer it to blacking, because substances spilled can be more easily washed off, and flatirons and the bottoms of kettles are cleaner than if stove polish is carelessly used.

If blacking is used it should be applied when the stove is slightly warm, both for the sake of convenience and because some polishes are made with inflammable materials, such as turpentine. The stove should be well cleaned, covered with a very thin coat of blacking, and rubbed briskly and thoroughly with a dry brush. If a stove is blacked and polished in this way, the color should not come off on the bottoms of saucepans.

Nickel trimmings on stoves should be cleaned like other nickel (see p. 19).

Coal and wood stoves should be cleaned inside frequently and thoroughly, in order to save heat and fuel. Ashes should be removed every day, and once a week the soot should be brushed from the bottom of the lids. All flues should be cleaned regularly, especially those under and on top of the oven, through which hot air must circulate to heat it.

When the burners on gas stoves become clogged, they should be taken out, brushed, placed in a large pan, and boiled in water to which washing soda has been added in the proportion of one-half pound to 1 gallon, rinsed and brushed, wiped with paper or cotton waste, fitted back in the stove, and dried thoroughly by lighting the gas. The tray under the burners should be removed and washed frequently.

The burners and chimneys on oil or other liquid-fuel stoves should be kept in order in the same way as kerosene lamps. In most makes the burners are detachable, and when they become clogged may be cleaned like those on gas stoves.

The heating elements on electric stoves may be cleaned with water and a soft brush. Any particles burned to char may be brushed out.

KEROSENE LAMPS.

Kerosene lamps must be kept clean and filled if they are to burn with a good light and without odor. The reservoir should be filled to within an inch of the top. The charred portion of the wick should be rubbed off, the char removed from the wick tube and the burner,



FIG. 6.—Equipment for keeping lamps in order.

and the wick turned down just below the top of the tube. The chimney should be cleaned either by rubbing with tissue paper or by washing in hot soapy water, rinsing in clear hot water, and wiping perfectly dry; if there is any moisture on the chimney when the lamp is lit, the glass is likely to crack. The outside of the lamp and the shade should be dusted. It saves trouble to keep the materials used in cleaning lamps together in a tray, box, or basket (fig. 6).

STORAGE PLACES.

It is easier to keep a house in order if it is equipped with adequate storage facilities. "A place for everything and everything in its place" is a good old adage which, if heeded, saves time and strength. Less time is wasted in looking for misplaced articles if similar ones

are stored together and if the contents of boxes, drawers, and closets are suitably labeled or listed. Things that have outlived their usefulness should not be stored, even if there is ample space, for they simply add to the material that must be cared for without giving any service in return.

Such household storage places as attics, basements, cellars, and sheds do not, of course, need to be so frequently or carefully put in order as the living rooms, but they should be gone over often enough to keep their contents in good condition and to prevent dirt from being carried from them into the other parts of the house.

The cellar or basement may be damp and therefore requires special care, both because things stored in it may spoil and because the quality of the air in it affects that all over the house. It should be regularly ventilated, preferably with a cross current of air, and open windows and doors should be screened against insects and in some cases against dirt (see p. 4). Unplastered walls should be white-washed occasionally because the light color reflects the light and the whitewash is a germicide. In most cases the boxes or shelves in which things are stored should not be set directly on the floor, but raised on racks or blocks of wood to avoid dampness and mustiness. Old newspapers, magazines, and paper boxes should not be stored here because they tend to absorb moisture.

Compact and orderly arrangement in a clothes closet makes cleaning easier. Dresses, coats, and like garments may be kept on hangers on a rod across the closet, and shoes may be kept on a shelf near the floor of the closet. The clothes closet should be aired each day; leaving the door open every night is a good plan. Occasionally everything stored in the closet should be taken out, and floors, walls, and shelves thoroughly cleaned. Dusty closets are likely to harbor moths.

GENERAL DIRECTIONS FOR CLEANING A ROOM.

Cleaning a room according to a definite plan will save labor because the different steps in the process will not need to be repeated. When rooms near together are to be cleaned on the same day, it is often easiest to get all of them ready, then clean them all, and finally put them all in order.

Sweeping and dusting should be made as dustless as possible, for the object is to remove dust, not to scatter it. In sweeping, the strokes should be firm and even and taken in such a way that the broom or brush is kept on the floor most of the time and not flirited through the air. The dust cloth should be held in a fairly compact mass, so that the surface to be cleaned is wiped or polished and at the same time the dust is held by the cloth.

Small pictures and bric-a-brac should be dusted and removed from the room or placed in a pile and covered.

Draperies and portieres should be taken down or pinned up.

Furniture, mirrors, and pictures should be dusted and covered with cloths.

Radiators or registers should be cleaned. Each register should be lifted out, placed on a newspaper, and dusted thoroughly with a brush and an oiled cloth. The hot-air pipe should be brushed and the screen cleaned. The opening should be covered with newspaper and the register placed over it to prevent dust from dropping down.

The grate, the stove, or the fireplace should be cleaned.

The walls and ceiling and the baseboards should be brushed and dusted.

The floor and floor coverings should be cleaned according to the kind.

While the dust is settling, spots should be removed from the wood-work and the windows washed if necessary (see p. 16).

The covers may then be removed from pictures and furniture, and should be shaken out of doors if possible.

Then the room and furniture should be dusted thoroughly, beginning at the top of the room and working down.

When a room is cleaned with a vacuum cleaner, the order of proceeding is different. The room is first dusted, then the vacuum cleaner is used on upholstery, hangings, walls, and carpets or rugs, and finally the floor is dusted. By this method of cleaning fewer articles need to be moved, no dust is scattered, and more dirt is actually removed. A vacuum cleaner, therefore, saves labor, even though with some types part of the work is harder than sweeping.

HOUSEHOLD PESTS.

Insect and animal pests are not only disagreeable, but in many cases a menace to health and injurious to the house and furnishings. Scrupulous cleanliness everywhere on the premises is the best preventive, but in addition the following precautions should be taken: Screening windows and outside doors; filling cracks and holes in floors and walls; clearing up all crumbs and bits of food promptly; leaving no food uncovered; keeping garbage in closed receptacles and insisting on its prompt disposal; removing or disinfecting all decaying animal or vegetable matter in or near the house; covering rain barrels and allowing no other stagnant water in or near the house.

In spite of all precautions, insect and animal pests frequently get into a house and must then be exterminated or controlled. Poisoning, trapping, fumigating, and the use of repellents are some of the methods employed. Unfortunately, some of the most efficacious are dangerous to human beings and should be used only by responsible persons. Poisons should never be placed where they can be taken by accident, and special care should, of course, be used to keep them

away from children. Inflammable or explosive materials such as gasoline and benzine should be handled with the usual precautions (see p. 8).

Ants.—Ants are attracted by various food substances, especially fats and sugars; therefore these foods should be kept in closed containers and crumbs or small amounts spilled on shelves or tables cleaned off at once.

The most effective way of ridding a house of ants is to find and destroy the nest by treating it with carbon bisulphid, benzine, gasoline, or kerosene. Or, if the nest itself can not be found, oftentimes the ants may be traced to the opening or crack through which they enter. Squirting kerosene into it or plugging it with cotton saturated with the oil will in many cases drive them away.

A temporary expedient for controlling ants is to moisten small sponges with sweetened water and place them where the ants are most numerous. Attracted by the sugar they will crawl into the sponges and may be killed by dropping in boiling water. The sponges should be baited again with the sweetened water, and, if necessary, set in different places until the colony leaves the house.

A more effective but also more dangerous method is to moisten the sponges with a sirup made by dissolving 1 pound of sugar in 1 quart of hot water and adding 125 grains (about $\frac{1}{4}$ ounce) of arsenate of soda. Some of the ants apparently carry this poisoned liquid back to the nest and feed it to the others there, thus gradually killing the entire colony. This mixture must be used with the greatest care, as it is poisonous to both human beings and domestic animals.

Bedbugs.—Kerosene, gasoline, and benzine when forced into cracks or crevices infested by bedbugs are effective in controlling them. Successive applications should be made at intervals of 3 or 4 days for 10 days or 2 weeks so that the bugs hatched in the intervening periods may be killed.

Boiling water kills both bugs and eggs, but it can seldom be used, for it injures paint and varnish. A solution made of 1 part corrosive sublimate to 5 parts boiling water is also effective and may be used to wash furniture and woodwork. Corrosive sublimate is a deadly poison and must be used with extreme care.

Fumigating rooms with sulphur will also kill many bedbugs but can not be depended upon for extermination. Sulphur fumigation is never advised for rooms containing fine wall papers or valuable furnishing, because it tends to bleach colors.

Carpet beetles, "buffalo bugs," or "buffalo moths."—Carpet beetles are difficult to exterminate once they become established in a house in which the floors have carpets tacked over them. Bare floors with rugs do not offer them the same advantages for hiding and breeding.

If these pests are found, the carpets should be taken up, thoroughly cleaned outside of the house, sprayed with gasoline or benzine, and, if possible, aired and sunned. The floor should be thoroughly scrubbed with soapsuds, special attention being given to cracks and crevices along baseboards, and sprayed with gasoline, benzine, or kerosene. Before the carpet is replaced the cracks should be filled with a crack filler. Closets infested with these beetles should be scrubbed and sprayed in the same way as floors. Hydrocyanic-acid gas and sulphur fumes are also effectual in exterminating carpet beetles.

Cockroaches or waterbugs.—Several varieties of these are prevalent in various parts of the country. They are usually attracted by dampness, bits of food and trash of all kinds, and are particularly difficult to get rid of where one can not control conditions throughout the building. Sprinkling borax, sodium fluorid, or pyrethrum freely and persistently day after day wherever cockroaches appear or are likely to hide seems to be a fairly successful method of extermination. Of all powders sodium fluorid is the best.

Small dishes filled with a paste made of plaster of Paris, flour, and water placed where the roaches have appeared is another effective method. Still another good method, which has the added advantage of placing the poison where it can not be accidentally touched by a person or a household pet, is to put daubs of phosphorus paste on the inside of small tubes of paper.

Fleas.—If a room becomes infested with fleas, the carpet or rugs should be taken out of doors, cleaned, and sprayed with benzine or gasoline. The floor should be washed with soapsuds, special attention being given to cracks between boards and along baseboards, and rubbed or sprayed with gasoline, benzine, or kerosene.

Flies.—So far as possible flies should be kept out of the house by the use of screens; if they do get in, every effort should be made to drive them out or kill them. Flytraps, fly paper, insect powder, and poisons are used. One of the best means of killing flies is to place a solution made of 1 part formaldehyde to 10 parts water in shallow dishes about the house. A piece of bread in each dish will make the bait more attractive.

Moths.—Woolen materials and garments should be thoroughly cleaned, brushed, aired, and sunned before they are put away, in order to dislodge any moth eggs or larvæ on them. Sealing woolen garments in clean, heavy paper bags will keep moths out. Tobacco, camphor, naphthalene, cedar, and tar are all repellents for moths, and are of value if garments are put away entirely free from moths and moth eggs. None of these agencies, however, can be relied on to prevent eggs and larvæ left in the garment from developing and eat-

ing the woolens if they are left on open shelves or in very loosely constructed containers. Naphthalene in the form of moth balls or flakes, when fresh and used at the rate of one pound to a trunk of average size, will not only protect clothing stored in the trunk from becoming infested, but will kill infestations that by chance escape the cleaning process. Fumigation by carbon disulphid is an excellent method of immediately killing out infestations in clothing stored in tight containers and can not be recommended too highly. Directions for this are given in another bulletin of this series.⁴

If a closet becomes infested with moths, it should be sprayed or fumigated as suggested for carpet beetles.

Rats and mice.—All openings through which rats and mice would be likely to enter houses should be closed or screened. Holes should be filled up with a mixture of cement, sand, and broken glass or crockery, or covered with a sheet of metal.

Traps of various kinds are used for catching rats and mice. If a house is badly infested, traps should be set in several places at a time.

Rats and mice may also be poisoned, but such methods are usually more to be recommended for barns, poultry houses, and outbuildings than for houses, because the poisoned animals may die in the walls and foundations of the house, making it almost uninhabitable for some time. Moreover, the poisons used are extremely dangerous, and must never be placed where a person or household animal can reach them by accident. If poison must be used, barium carbonate is, perhaps, the cheapest and most effective. One way to use it is to mix 1 teaspoon of the mineral with 8 teaspoons of rolled oats, add enough water to make a stiff paste, and place this poisoned bait where the animals are known to run, using a teaspoon in a place; or the poison may be spread on fish, bread and butter, or moistened toast, and placed in the runs. Strychnine, in the form of crystals of strychnia sulphate, is sometimes employed either by embedding the dry crystals in meat or toasted cheese, or by soaking oatmeal, wheat, or corn in a strychnine sirup (1 ounce of crystals dissolved in 1 pint of boiling water and mixed with 1 pint of thick sugar sirup), but this poison acts too quickly to be advisable for use in the house.

Silverfish.—These insects are attracted by starch and are particularly injurious to books, papers, and starched clothing. Advantage may be taken of this fact in destroying them. An effective method is to mix about 1 teaspoon (three-fourths dram) of powdered white arsenic with one-half cup of flour, make a thin paste by adding boiling water, spread it on small pieces of cardboard, and place them when dry where the silverfish have been found.

⁴ *Farmers' Bul.* 799, Carbon Disulphid as an Insecticide.

Pyrethrum and sodium fluorid are also effective in controlling these insects.

Other publications of this department giving added information about household pests are listed on page 31.

GENERAL RULES FOR EASY CLEANING.

The more important points brought out in this bulletin may be summarized as follows:

Keep dirt out of the house by cleaning the walks, steps, porches, and sills regularly and often, by screening windows and doors near the ground, and by insisting on having muddy shoes and coats cleaned or left outside.

Lessen the number of dust-collecting places, such as unnecessary cupboards, grooved and carved woodwork, floors with cracks, rough-finished walls, elaborately carved and upholstered furniture, superfluous draperies, and bric-a-brac.

Remove dirt frequently and systematically. This keeps the house and furnishings in better condition and makes the need of heavy cleaning less frequent.

Clean by taking the dirt away, not by scattering it to settle again elsewhere.

Do heavy cleaning a little at a time to avoid the hard work and discomforts of the old-fashioned spring and fall housecleaning.

Have a supply of good cleaning tools such as your work calls for and keep them in good order in a convenient place.

Use water and cleaning agents sparingly because otherwise they may spoil finishes and weaken glue, paste, or cement.

Be on the lookout for troublesome insects and animals and take prompt measures to get rid of them if they appear.

Make all the family help by leaving things where they belong and in good condition.

**PUBLICATIONS OF THE U. S. DEPARTMENT OF AGRICULTURE OF
INTEREST IN CONNECTION WITH THIS BULLETIN.**

AVAILABLE FOR FREE DISTRIBUTION BY THE DEPARTMENT. .

- The Farm Kitchen as a Workshop. (Farmers' Bulletin 607.)
Removal of Stains from Clothing and Other Textiles. (Farmers' Bulletin 861.)
Fire Prevention and Fire Fighting on the Farm. (Farmers' Bulletin 904.)
Farm Home Conveniences. (Farmers' Bulletin 927.)
Water Systems for Farm Homes. (Farmers' Bulletin 941.)
Home Laundering. (Farmers' Bulletin 1099.)
Selection of Household Equipment. (Yearbook Separate 646.)
The House Centipede. (Farmers' Bulletin 627.)
Cockroaches. (Farmers' Bulletin 658.)
Hydrocyanic-acid Gas against Household Insects. (Farmers' Bulletin 699.)
Flytraps and Their Operation. (Farmers' Bulletin 734.)
House Ants—Kinds and Methods of Control. (Farmers' Bulletin 740.)
The Bedbug. (Farmers' Bulletin 754.)
Carbon Disulphid as an Insecticide. (Farmers' Bulletin 799.)
The House Fly. (Farmers' Bulletin 851.)
House Rats and Mice. (Farmers' Bulletin 896.)
Fleas and Their Control. (Farmers' Bulletin 897.)
The Silverfish or "Slicker," an Injurious Household Insect. (Farmers' Bulletin 902.)
Some Common Disinfectants. (Farmers' Bulletin 923.)
The House Rat, the Most Destructive Animal in the World. (Yearbook Separate 725.)
The Argentine Ant as a Household Pest. (Farmers' Bulletin 1101.)
Book Lice, or Psocids, Annoying Household Pests. (Farmers' Bulletin 1104.)

**FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING
OFFICE, WASHINGTON, D. C.**

- Water Supply, Plumbing, and Sewage Disposal for Country Homes. (Department Bulletin 57.) Price, 10 cents.

FARMERS' BULLETIN 1181 *A1.9:11*
UNITED STATES DEPARTMENT OF AGRICULTURE

Raising Sheep on Temporary Pastures



TEMPORARY pastures for sheep may be used for all or part of the grazing season. Their use makes it possible to fit the flock into the livestock farming system with very little change in the usual methods of producing feed and pasturage for cattle and swine.

By the use of temporary pastures the flockmaster is able to maintain a uniform milk flow of the ewes, which insures rapid development of the lambs to market size.

The use of temporary pastures assists greatly in the prevention of infection by stomach worms and other internal parasites. Frequent changes to new pasturage can be made and losses by death and lack of thrift prevented.

A system of temporary pastures for sheep raising permits the use of lands of low fertility and at the same time insures a revenue from them without an expensive outlay for commercial fertilizer. Only lime, phosphorus, and inoculating material are necessary to enable poor soils to produce legumes.

This bulletin explains the advantages and methods of using temporary pastures for sheep and gives results of experiments conducted at the Bureau of Animal Industry experiment farm, Beltsville, Md.

Contribution from the Bureau of Animal Industry

JOHN R. MOHLER, Chief

Washington, D. C.

March, 1921

RAISING SHEEP ON TEMPORARY PASTURES.

F. R. MARSHALL and C. G. POTTS, *Animal Husbandry Division.*

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CROPS USED FOR TEMPORARY PASTURES.

ANY ANNUAL CROPS that are sown for the purpose of being pastured off before maturity are called temporary pastures.¹ They may be used as the sole pasture crop for all or for a part of the grazing season. In the experiments reported in this bulletin the experimental flock was grazed all the season without the use of permanent grass pasture. The crops were grazed off in the following order: Fall rye, fall wheat, alfalfa, spring-sown oats and peas, rape, cowpeas, soy beans, fall barley, and fall wheat.

In many localities fall wheat or rye is grazed during winter and early spring and then allowed to mature a grain crop. The same practice is possible with spring-sown cereals, but is less often practicable with cowpeas and soy beans. The temporary pasture crops suitable for sheep are equally valuable for hogs. In case a crop is to be used for both kinds of stock the feed should be kept fresh for the sheep, either by dividing the field or having the hogs follow the sheep.

Surplus cereal and legume crops from the pastures can be cured into first-class winter roughage for sheep.

NOTE.—R. B. Millin, now of the Montana Agricultural College, assisted in the early development of the experiments reported in this bulletin.

¹ The occasional pasturing of a permanent crop like alfalfa is also employed in a system of temporary pastures.

ADVANTAGES OF TEMPORARY PASTURES.

The use of temporary pastures aids in utilizing the economic peculiarities of sheep. This is true because a succession and a variety of fresh forage crops produce the maximum milk flow of the ewe, and lambs are largely a milk product. The lambs most in demand at the markets are those that reach a desirable weight and finish while still sucklings. Returns from the sale of such lambs are the quickest that can be obtained for a finished product in any line of livestock raising.

Permanent grass pastures are well suited to ewes with lambs, but as the lambs become larger and able to use more milk the feed is likely to be cut short by dry weather. Special seedings of annual crops at different dates give greater assurance of good milk-producing pasture when most needed. In most parts of the country, however, lambs can be marketed best before the usual date of dry weather.

On most high-priced lands a ewe's feed can be produced more cheaply from annual crops sown to be grazed than on permanent grass pasture. The extent to which the extra amount and value of the forage crop will offset the extra costs of fencing, plowing, and seeding depends upon the value of the land.

PREVENTION OF PARASITES.

Prevention of infection by stomach worms and other internal parasites is one of the most general and important advantages to be obtained by using temporary pastures for sheep. Losses by death or lack of thrift are most serious among lambs of flocks that are kept season after season on old grasslands. With only a few sheep on a large area of grass which is also pastured by other stock, the danger is less likely to be serious. With closer grazing by sheep during several months of each season the danger is increased and is most serious in sections or in seasons of high temperature and excessive moisture. Alternating permanent pastures during the season does not materially lessen the danger.

Though rotation of temporary pastures is the most practicable means of evading stomach-worm infection, the plan requires that the flock does not go on a field a second time unless the land has been plowed in the interim or time enough has elapsed to cause the death of the stomach-worm larvæ that are left upon the field grazed by infected sheep.²

On farms provided with a large number of fields with fences suitable for sheep, a succession of clean temporary pastures can be pro-

² Department of Agriculture Circular 47, "The Prevention and Treatment of Stomach Worms," explains the development of these parasites and the method of holding them in check by rotation of pastures.

vided. In most cases it is more economical and more satisfactory to provide permanent or movable fences for a number of smaller pasture lots, on each of which two or three crops can be grown each season to a stage suitable for grazing. On larger lots a system of hurdles can be used to permit access to a portion furnishing only one or two days' feed. It is more satisfactory to have lots of a size to furnish from 10 to 14 days' feed for the flock. Two weeks is the longest time that one piece of ground should be used during the warmer part of the season. Young lambs are most susceptible to injury from parasites and are exposed to the least possible danger if moved to fresh ground at intervals of not more than two weeks.

IMPROVEMENT OF SOIL.

An additional advantage in using temporary pastures for sheep raising is the improvement of the soil. The greatest demand upon fertility is avoided by not requiring the crops to mature seed. All the manure is distributed upon the ground together with all uneaten parts of the crop. With legume forages the gain to soil is especially valuable and allows production of still larger crops which are again returned to the land diminished only by the materials contained in the increased size of lambs or ewes while on that particular crop.

RESULTS OF EXPERIMENTS WITH TEMPORARY PASTURES.

A study of the possibilities of sheep raising under a temporary pasture system was begun in 1916, when a field of 30 acres at the Bureau of Animal Industry's experiment farm at Beltsville, Md., was set aside to be used exclusively for sheep. The objects and results of the experiment relate to amount and value of pasturage; carrying capacity and value of various crops; health of sheep; size of lots and methods of fencing and grazing; effect on the land.

AMOUNT AND VALUE OF PASTURAGE.

On the 30-acre field used in this experiment sufficient pasturage was produced to furnish an average of 505 days' grazing on each acre for a mature ewe. This is equivalent to about 2 sheep an acre for a season of 250 days, or $2\frac{1}{2}$ sheep for a 200-day period. This pasturage is much more than could be obtained from perennial grass grown on land of the character and value of that used in the experiment, but not more than can be obtained from the best blue-grass pastures. Good land used for such a succession of temporary pastures should produce from 50 to 100 per cent more pasturage than was obtained in this instance.

In a system like this there is not much choice of crops to be used in different months. It is chiefly necessary to make sure of having one

crop ready when the preceding one is finished. All the crops used in 1919 stimulated a good flow of milk in the ewes, produced good growth in the lambs, and, after weaning, put the ewes in good condition for fall breeding.

The ewes and lambs were all purebred Southdowns. Some of the ewes raising lambs received a half pound of grain each daily until May 10, and 22 head of ewes in a fall breeding experiment received a light feed of grain during September and October. All the lambs were kept for breeding purposes and were fed some grain throughout the summer. In calculating how far the feed actually produced would go for grown sheep it was considered that a lamb ate one-

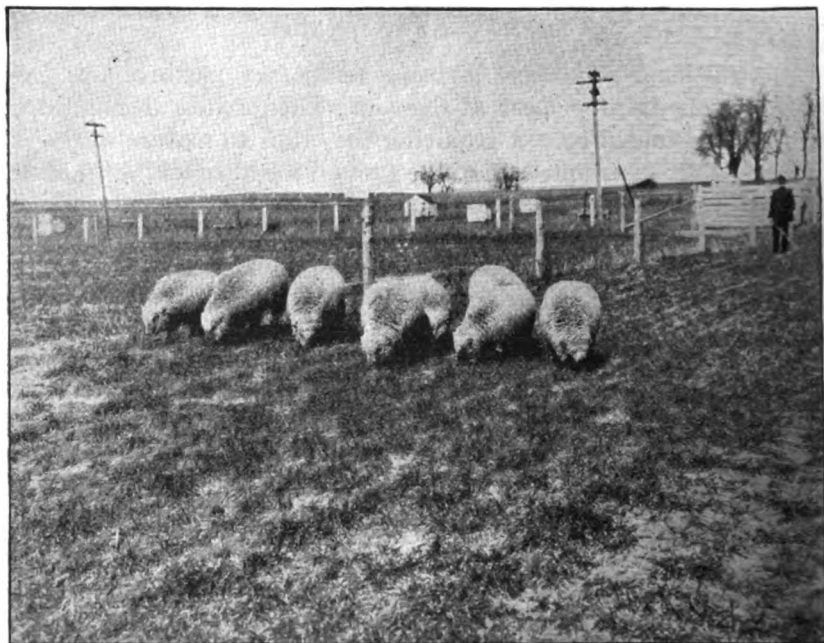


FIG. 1.—Wheat is a very satisfactory spring forage. Yearling ewes on wheat at Beltsville, Md., March 16, 1917.

fourth as much as a sheep until July 1, and after that one-half as much. Putting in the crops used in 1919 required 60 acres of plowing and seeding, a total of 520 hours' work for a man and a team.

Under the conditions of this experiment fall-sown wheat and spring seedings of oats and peas³ have been most satisfactory for grazing in spring and early summer. Soy beans are ready for grazing about the middle of July and furnish most of the feed until October. In November fall-sown wheat and rye have been used most, though late seedings of corn and velvet beans were used in 1919. The land is still too poor for rape, a good stand having been

³ Oats and field peas, sown together at the rate of 1½ bushels of each per acre.

secured in 1919 for the first time on 1½ acres that had received an extra coating of manure.

Two crops were grown in 1919 on each forage lot. In the latitude of southern Maryland three crops can be raised on one-third the area where the land is used in the manner described.

CARRYING CAPACITY AND USE OF VARIOUS CROPS.

The number of days of grazing from 1 acre of each crop in 1919 was as follows, calculated on its pasture value for one mature ewe.

	Days.		Days.
Rape	392	Cowpeas	210
Soy beans	319	Alfalfa	882
Oats and peas	319	Barley	278
Wheat	309	Rye	180

Pasturing on wheat and rye began at the same time, April 8. The wheat continued to be suitable for use until the first week in

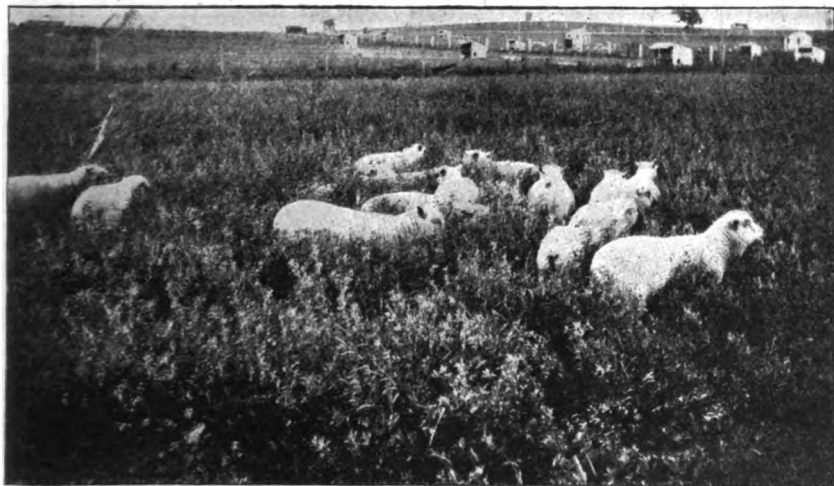


FIG. 2.—Lambs in alfalfa, Beltsville, Md., July 7, 1917.

May. A second growth was grazed later by a bunch of yearling ewes. Rye is not relished by the sheep so much as wheat, and heads out more quickly. In this stage sheep do not eat either leaves or heads to the same extent that they eat wheat.

Rye is especially valuable for winter grazing in the Southern States. In winter-wheat sections that crop is grazed in winter and part of the spring with great advantage to the animals and to the grain crop as well.

Alfalfa was used in May and again, for ewes, in October. This crop does not fit well in a temporary pasture system on account of the likelihood of larvæ left on the ground at one grazing infecting sheep at a later grazing. Cutting one crop for hay before the second

grazing may reduce this danger, but does not wholly overcome it. Any such risk from feeding the cured hay would be slight.

Oats and peas grown together furnish most of the grazing, after using the wheat, until rape and soy beans are ready. The oats and peas may be sown early, and seedings at different dates insure later pasturage that is still succulent and tender. Our first seeding of the crop in 1919 was on April 6, and it was ready for grazing on May 28.

Rape, as stated, has not been largely used on the land described, because of the low fertility of the soil. The crop of 1919 was planted on April 10 and required 10 weeks to be ready for pasturage. Plantings made in warmer weather should grow more rapidly, but in mid-summer rape becomes bitter and is not relished so much as earlier. On rich land rape can be the main forage crop from the time the



FIG. 3.—Ewes and lambs in rape, Beltsville, Md., June 20, 1917.

first seeding is ready for use. Well-grown plants withstand a good deal of frost, and the crop should be useful for extending the grazing season late into the fall. Lambs require several days to learn to eat rape readily, and it is an advantage if they can spend a few hours each day on some other crop until they have learned to like rape. Bloating rarely occurs in sheep pasturing on rape, but it is well to see them frequently during the first few days on this crop or in frosty weather. Rape ordinarily yields better and is grazed with less waste when planted in drills.

Soy beans in the 1919 rotation of forages were planted from June 11 to August 4. Pasturing of the earliest planting was begun one month after seeding, though it is usually desirable to allow 5 or 6 weeks between seeding and grazing. This particular crop of 3 acres carried 66 lambs for 14 days in July and then 70 ewes for another 9

days. After 25 days there was new growth enough to carry 35 ewes for 18 days. This feature of making new growth after being grazed is a valuable one in soy beans, and sheep and lambs eat the crop with great relish.

Cowpeas are planted at the same time as soy beans and grow at about the same rate. They produce feed similar in amount to that obtained from soy beans, but are less palatable for lambs, and the crop does not make so much of a second growth as do soy beans. The arrangement of the fields used in this experiment, the order of seeding and grazing the crops, and the amount of pasturage produced are shown in the map of the field in figure 6.



FIG. 4.—Lambs in soy beans, Beltsville, Md., July 10, 1917.

HEALTH OF SHEEP.

Prevention of injury by internal parasites is a principal advantage of providing temporary pastures for sheep under a plan that allows their going to fresh ground at intervals of not more than 2 weeks. It is considered that most flocks have some degree of infection of stomach worms. In warm, moist weather the eggs in the droppings of the older sheep develop in a few days into larvæ, which are especially injurious when taken up by lambs. These larvæ are largely destroyed when land is plowed, and it is for this reason that plowing is recommended in reseeded land after a crop has been pastured.

Older sheep are less susceptible than lambs to the effects of stomach worms. There is less danger in allowing them to remain longer than 2 weeks on the same ground or in using up feed left in fields from which lambs have been removed. Because of the continued chance of infection of lambs from grass along fence rows and in unplowed

yards and barn lots complete freedom from parasites is seldom obtained.

In pasturing ewes and lambs in our experiments of the last two years stomach worms have not been found, except in a few cases in August and September, and these were overcome by giving the copper-sulphate treatment. In flocks changed to fresh ground every 2 weeks treatment would seldom, if ever, be needed for lambs mar-

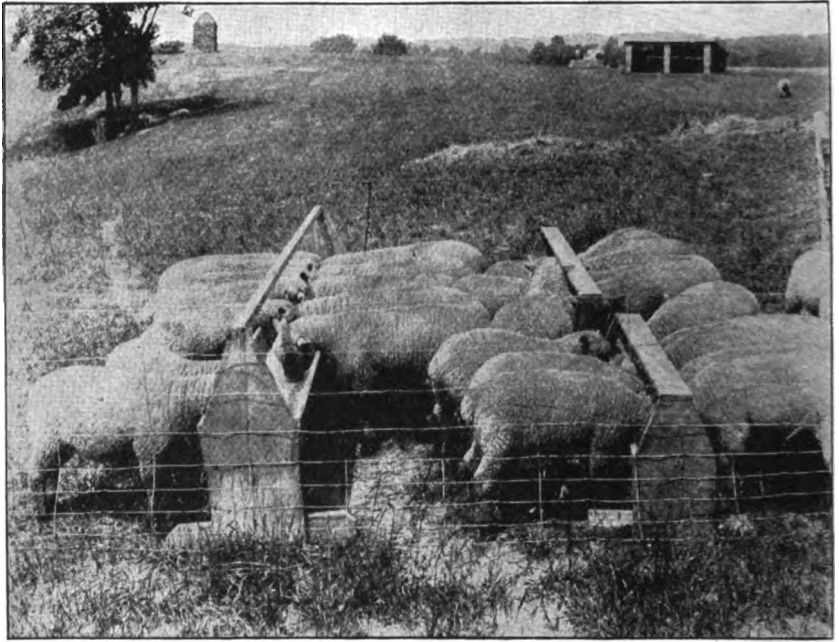


FIG. 5.—Feeding grain to lambs in an inclosure in the field. Lambs have access by means of a creep.

keted in June and July. Temporary pastures on clean land are particularly useful for ewe lambs retained as breeders, though treatment for parasites may sometimes be advisable and may safely be used as a precautionary measure.⁴

The order in which various crops were used and the length of time spent upon each is shown below for the flock containing the young lambs and for the lambs alone after the time of weaning.

⁴ Medicinal treatment for stomach worms is described in Department of Agriculture Circular 47.

Order of grazing flock of ewes and lambs followed by lambs alone in experimental work.

Date.	Crop.	Field No.	Acres in field.	Number of lambs.	Number of ewes.
1919.					
Apr. 8 to 19.....	Fall wheat.....	3	3	52	44
Apr. 20 to 26.....	Rye.....	6	3	52	44
Apr. 27 to May 8.....	Wheat.....	4	5.3	66	53
May 9 to 27.....	Alfalfa.....	8	2	66	53
May 28 to June 10.....	Oats and peas.....	5	5.8	66	56
June 11 to 17.....	do.....	(1)	3.7	66	56
June 18 to July 1.....	do.....	(2)		64	15
July 2 to 12.....	Rape.....	1	3	66	
July 13 to 25.....	Soy beans.....	2	3	66	
July 26 to Sept. 11.....	do.....	3	3	62	
Sept. 12 to Oct. 10.....	do.....	6	3	(*)	
Oct. 11 to 25.....	Corn and velvet beans.....	9	2	59	
Oct. 26 to Nov. 5.....	Fall barley.....	5	5.8	(*)	
Nov. 5 to 25.....	Fall wheat.....	2 and 10	9	(c)	

¹ Part of 10.

² Other part of 10.

³ Not grazed.

From April 17 to June 18, 14 dry and yearling ewes followed the ewes-and-lambs flock.

After July 2, the 70 ewes followed the lambs and also grazed Field 10, 3.7 acres soy beans, and Field 4, 5.3 acres corn and soy beans.

SIZE OF LOTS AND METHODS OF FENCING AND GRAZING.

The convenient size for temporary pasture lots is determined mainly by the size of the flock. For health and for economical use of the pasturage it is undesirable to keep sheep on the same ground more than from 10 to 14 days. The most generally useful size of lot is 1 acre to 25 sheep. This area on an average furnished 14 days' feed.

Arranging the size of lots on the basis of 1 acre to 25 sheep is more satisfactory than seeding larger areas and using hurdles to permit advance to fresh feed each day. Less labor is necessary and by going to entirely new ground after 10 or 12 days the danger of picking up parasite larvæ on ground grazed over earlier is prevented. With a 1-acre lot for 25 ewes or correspondingly larger ones for larger flocks it is an added advantage if their length is two or three times the breadth. With a heavy crop of forage that would last longer than was considered safe to hold the flock on the same ground, a short piece of cross fence can readily be put down to divide the pasture into two parts. The smaller lots are also convenient with purebred flocks to provide for the separate pasturing of smaller lots of ram and ewe lambs.

Movable fencing is not likely to be satisfactory for the outside-lot fences unless the whole area to be used lies in a long strip with side fences, when only two end pieces need to be in place at one time for the ground being grazed.

A handy style of movable fence consists of a roll of 32-inch woven wire supported by posts made of half-inch iron rods. This post is

known as the Illinois post.⁵ Eight inches from the foot there is a branch at right angles to the post. This branch runs out 6 or 8 inches and turns downward parallel with the post itself. This post can be set readily by pressing on the branch with the foot. The shape of the bottom part gives bracing enough to prevent pushing over by the sheep. The bottom of the fence is kept in place by passing the post between two of the lower wires. The top wire lies in a groove made in the top of the post.

EFFECT ON THE LAND.

An increase of 100 per cent in the amount of pasturage produced has been obtained during four years' use of 30 acres of land for temporary pasture experiments described in this bulletin. In 1916 this 30-acre field used exclusively in growing temporary pasture crops grazed by sheep carried 6 yearling ewes and 22 2-year-old ewes with 24 lambs. They were in rather low condition at the close of the pasture season. In 1919 the same land furnished good grazing for 70 ewes and 66 lambs for 200 days and a considerable quantity of unused feed was plowed under.

This field is a low-lying, flat piece of land decidedly below average fertility. The results obtained are far below what would be secured on many farms, and demonstrates the advantages and general style of practicing such a system rather than maximum quantity of feed which can be produced. The soil is a heavy, silty clay, parts of which, even after tile draining, are at times too wet for plowing in summer months. It had been badly run down by cropping without manure, as is shown by the poor returns in 1916, a season of average rainfall. The improvement in soil condition has been due to the manure left distributed upon the land by the sheep, to the plowing in of unused parts of crops, and to other beneficial effects of legume crops, soy beans in particular. In order to get satisfactory crops of cowpeas and soy beans 40 tons of ground limestone and 2 tons of acid phosphate in all were applied to 25 acres of the field in the fall of 1916 and in 1917. During the last three seasons 15 acres also received a single application of manure at the rate of 10 tons of fresh manure per acre.

The soil is too heavy to be benefited by trampling; in fact, holding the sheep on the lots in wet times has had a harmful effect. The sheep were kept night and day upon the crop in use without access to any other pasturage. Shade and water were provided in each lot.

⁵ The Illinois post and other kinds of equipment for sheep raisers are illustrated and described in *Farmers' Bulletin 810*, "Equipment for Farm Sheep Raising."

FIELD 1.-3 ACRES RAPE 69 ewes } June 18 to 28 14 lambs } 66 lambs } July 2 to 12 70 ewes } July 12 to 16 25 ewes } Aug. 29 to Sept 5 MILLET 25 ewes } Aug. 29 to Sept 5 13 ewes } Sept. 18 to Oct. 20	FIELD 10. 3.7 ACRES OATS AND BEANS 56 ewes } June 11 to 17 66 lambs } 15 ewes } June 18 to July 1 64 lambs } 70 ewes } July 2 to 6 SOY BEANS 34 ewes } Sept. 15 to Oct. 8 30 ewes } Nov. 10 to 24.	FIELD 9. 2 ACRES CORN AND BEANS 70 ewes } July 7 to 12 CORN AND VELVET BEANS 59 lambs } Oct. 11 to 25 33 ewes } Oct. 29 to Nov. 5	FIELD 8 2 ACRES ALFALFA 58 ewes } May 9 to 66 lambs to 27 ALFALFA 25 ewes } Sept. 6 to Oct. 10
FIELD 2.-3 ACRES SOY BEANS 66 lambs } July 12 to 26 70 ewes } July 26 to Sept 5 35 ewes } Aug. 29 to Sept 5 WHEAT 24 lambs } Nov. 4 to 25		FIELD 7.-2 ACRES RYE 9 ewes } 11 yearlings } Apr. 8 to 14 9 ewes } 9 yearlings } Apr. 14 to 21 7 ewes } 9 yearlings } Apr. 21 to 27	
FIELD 3.-3 ACRES. WHEAT 44 ewes } April 7 to 20 52 lambs } 15 ewes } April 27 to May 21 SOY BEANS 62 lambs } July 26 to Sept. 1 35 ewes } Sept. 2 to 14	FIELD 6.-3 ACRES RYE 12 ewes } 9 lambs } April 11 to 26 44 ewes } April 21 to 27 52 lambs } 14 ewes } May 20 to 27 SOY BEANS 60 lambs } Sept. 11 to Oct. 10 25 ewes } Oct. 11 to 15		
FIELD 4 -5.3 ACRES WHEAT 58 ewes } April 27 to May 8 66 lambs } 14 ewes } May 28 to June 17 69 ewes } June 27 to July 1 CORN AND SOY BEANS 33 ewes } Oct. 9 to 29	FIELD 5-5.8 ACRES OATS AND BEANS 58 ewes } May 28 to June 10 66 lambs } 70 ewes } July 15 to 26 BARLEY 26 ewes } Oct. 15 to 27. 54 lambs } Oct. 25 to Nov. 6.		

FIG. 6.—Diagram showing the rotation of crops and the amount of grazing afforded by each field on the specialized sheep farm at Beltsville, Md., 1919.

FORAGE ROTATIONS FOR DIFFERENT SECTIONS.

Although the crops described seem best adapted to the section near Washington, in which the farm is situated, it does not follow that they would be best for sections in which climatic conditions are very dissimilar. For instance, in New York and the New England States, rye, oats and field peas, and rape should form the principal part of the rotation, with alfalfa or permanent pasture to fill the gap between rye and oats and field peas, the last two being grown together. Plantings of rape following both of the crops would furnish feed in the autumn as long as the sheep could be left out.

In the South Atlantic and Gulf Coast States a greater variety of forage crops is available from which to make selection. The following table indicates groups from which selection could be made, together with the months which they would be most desirable for sheep pasture.

Group.	Crops.	Time available for pasturing.
1	Wheat, oats, rye, Italian rye grass, or rape.....	Jan. 1 to Apr. 30.
2	Lespedeza, Bermuda grass, carpet grass, ripe oats, alfalfa.....	Mar. 1 to June 30.
3	Early varieties of soy beans and cowpeas.....	June 1 to July 30.
4	Late varieties of soy beans, cowpeas, velvet beans, sorghum and millet.....	July 1 to Nov. 30.
5	Winter rye, oats, barley, wheat, and rape.....	Oct. 15 to Dec. 31.

¹Group 2 could be cut later for hay.

Group 2 consists of meadow or permanent pasture plants which could be pastured for a few weeks each spring without danger of serious infection from stomach worms. The choice of the crops from each of these groups should depend upon the degree of success with which they are grown in any particular section.

ROTATIONS WITH PERMANENT PASTURES, STUBBLE FIELDS, AND TEMPORARY PASTURES.

When it is not practicable to use a system of temporary pastures to provide the change of pasture necessary for protection from parasites, an effective system can be arranged in the regular crop fields of most stock farms, provided there is a sufficient number of fields having sheep fence. It is necessary that the lambs, and so far as possible the ewes, should be moved to new pasturage at intervals of not longer than 2 weeks without returning to any land that has not been plowed since it was grazed by sheep. In freezing weather these frequent changes are not required from a health point of view.

In a plan of providing a change of pastures in a stock-farm crop rotation, the earliest grazing is furnished by fall-sown wheat or rye. This can be used for 2 weeks in freezing weather even though the crop has been grazed previously during the winter. Following this, the flock is placed on permanent grass pasture upon which there were

no sheep during the previous year. If the second, or grass pasture, free from infection, is not available, a red-clover crop is used. Ordinarily this would be the same land upon which the sheep grazed wheat at the beginning of the previous year. In most sections the danger of infection in such case would not be a serious one. By the time the third change is necessary some clover fields have usually been harvested for hay and the second growth can be used for grazing. At this time of year (early fall) on farms producing such crops as mentioned for other livestock, lambs will usually be marketed. The ewes, if necessary, can return to some of the same land previously used. This does not allow the same degree of protection from parasites as would exist if there were no pasturing the second time without intervening plowing, but the effects of the parasite are less serious in older sheep, and treatment can be given to those ewes that show the need of it, to prevent a serious setback.

For ewes or for lambs that are carried later in the year, later pasturage is furnished in the stubble fields of the grain crops, and after that from rape sown in the cornfields. At a still later time the early fall-sown grain furnishes pasturage until the coming winter.

One or two acres of rape or some other forage crop will usually be found desirable as an insurance against possible shortage of pasturage in other fields, and more particularly as a safe and satisfactory feed for ewe lambs retained for breeding, and which can not safely remain with the ewes, particularly if the latter are spending part of their time upon land that may be infected.

SPECIALIZED SHEEP FARMING.

At present farms devoted mainly to sheep raising are not numerous. The opportunity exists for specializing in sheep raising with the same prospects of profit as are to be obtained from specializing in other lines of livestock production. In a plan of specialized sheep raising larger reliance necessarily would be placed upon temporary pastures. The results of experiments reported in this bulletin demonstrate that with the rotation of grazing and plowing for reseeding, land can be stocked heavily with sheep year after year without the development of serious difficulties. The necessary winter feed for a specialized sheep farm can be produced in connection with the regular temporary pastures. Extra seedings of leguminous crops can be harvested for hay, and in most seasons there is likely to be a part of some crop which is not needed for pasturing and can be cured for winter feeding. With the production of silage for a part of the roughage fed in winter the amount of land required is reduced to a minimum.

MOST SUITABLE SOILS.

Land suitable for a system of this kind should be level or only slightly rolling, and of a rather heavy soil texture in order that it

will not wash readily with the plowing necessary to provide the maximum amount of pasturage and protection from parasites.

PROTECTION FROM DOGS.

One of the principal drawbacks to sheep raising in the Eastern States is the damage done by sheep-killing dogs. Practical protection may be had in this system of farming by making the outside fence dogproof.⁶ The construction of a fence of this sort, although practically impossible on lands generally used as sheep pastures, is easily accomplished with little additional expense in level-lying lands as mentioned above.

DISTRIBUTION OF LABOR.

At present the labor situation is one of the principal problems in carrying on many agricultural projects. Day labor is practically

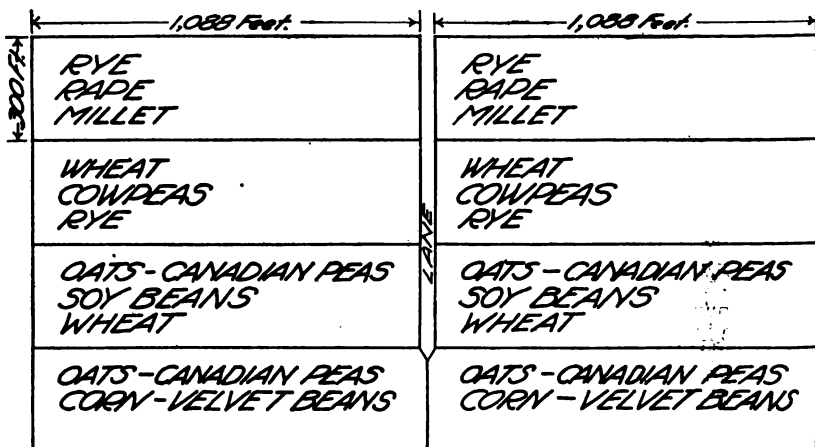


FIG. 7.—Showing a practical rotation of crops for each field for Central Atlantic and Corn-Belt States.

a thing of the past, so it is necessary for the farmer to arrange his work so that he will be able to give constant employment to all his men.

Specialized sheep farming offers the advantage of more even distribution of labor throughout the year than most other forms of specialized farming. There is no particular rush season, as the lambing season is over before the land is ready for spring planting. Other plantings are necessarily made from time to time throughout the summer in order that fresh pasturage may be available at all times. Such harvesting as must be done comes at different times throughout the year when feed is available for cutting.

Figure 7 shows a model farm plan for specialized sheep raising, and indicates a practical rotation of crops for each field for Central Atlantic and Corn-Belt States.

⁶ See figure 27, Farmers' Bulletin 810, "Equipment for Farm Sheep Raising."

SUMMARY.

1. Sheep can be successfully and economically raised with temporary pastures.

2. Numerous forage crops may be used for these pastures. The kinds used should depend largely upon the soil and climatic conditions in which they are to be grown.

3. More sheep can be raised per acre on temporary pastures than could be raised on permanent pastures on soils of equal fertility.

4. Pasturing sheep on annual crops makes it possible to rotate pastures more frequently and thus lessen the danger of infection by stomach worms and other internal parasites.

5. Temporary pastures, because they furnish an abundance of succulent green feed at all times, tend to increase the milk flow and make it more even throughout the lactation period.

6. Wheat, where it can be successfully grown, provides better winter and early spring pasture for sheep than rye.

7. Oats and field peas together make an excellent spring pasture for sheep.

8. On rather fertile land rape is the most economical forage for sheep.

9. Soy beans make one of the best temporary pasture crops for sheep where the soil is thin. This crop can be pastured from July until the first frost.

10. Either alfalfa or sweet clover makes a very satisfactory pasture for sheep, but care should be used to prevent bloat.

11. Pasturing sheep on small areas intensively cultivated makes it practicable to protect sheep from dogs by the use of a dogproof fence.

12. Specialized sheep farming provides an equal distribution of labor throughout, thus eliminating one of the principal farm problems.

**PUBLICATIONS OF UNITED STATES DEPARTMENT OF AGRICULTURE
RELATING TO SHEEP RAISING.**

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 Corn Cultivation. (Farmers' Bulletin 414.)
 Winter Oats for the South. (Farmers' Bulletin 436.)
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 Breeds of Sheep for the Farm. (Farmers' Bulletin 576.)
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 Sweet Clover on Corn-Belt Farms. (Farmers' Bulletin 1005.)
 Alfalfa on Corn-Belt Farms. (Farmers' Bulletin 1021.)
 Sheep Raising on Irrigated Farms in the Northwest. (Farmers' Bulletin 1051.)
 Stomach Worms in Sheep: Prevention and Treatment. (Department Circular 47.)

**FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING
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- The Management of Sheep on the Farm. (Department Bulletin 20.) Price, 10 cents.
 Domestic Breeds of Sheep in America. (Department Bulletin 94.) Price, 25 cents.
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U. S. DEPARTMENT OF
AGRICULTURE

FARMERS' BULLETIN No. 1181

RAISING SHEEP
ON TEMPORARY
PASTURES



TEMPORARY pastures for sheep may be used for all or part of the grazing season. Their use makes it possible to fit the flock into the livestock farming system with very little change in the usual methods of producing feed and pasturage for cattle and swine.

By the use of temporary pastures the flockmaster is able to maintain a uniform milk flow of the ewes, which insures rapid development of the lambs to market size.

The use of temporary pastures assists greatly in the prevention of infection by stomach worms and other internal parasites. Frequent changes to new pasturage can be made and losses by death and lack of thrift prevented.

A system of temporary pastures for sheep raising permits the use of lands of low fertility and at the same time insures a revenue from them without an expensive outlay for commercial fertilizer. Only lime, phosphorus, and inoculating material are necessary to enable poor soils to produce legumes.

This bulletin explains the advantages and methods of using temporary pastures for sheep and gives results of experiments conducted at the U. S. Animal Husbandry Experiment Farm, Beltsville, Md.

Washington, D. C.

Issued March, 1921
Revised April, 1932

RAISING SHEEP ON TEMPORARY PASTURES

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Bureau of Animal Industry*

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CROPS USED FOR TEMPORARY PASTURES

ANY ANNUAL CROPS that are sown for the purpose of being pastured off before maturity are called temporary pastures.¹ They may be used as the sole pasture crop for all or for a part of the grazing season. In the experiments reported in this bulletin the experimental flock was grazed all the season without the use of permanent grass pasture. The crops were grazed off in the following order: Fall rye, fall wheat, alfalfa, spring-sown oats and peas, rape, cowpeas, soybeans, fall barley, and fall wheat.

In many localities fall wheat or rye is grazed during the winter and early spring and then allowed to mature a grain crop. The same practice is possible with spring-sown cereals, but is less often practicable with cowpeas and soybeans. The temporary pasture crops suitable for sheep are equally valuable for hogs. In case a crop is to be used for both kinds of stock the feed should be kept fresh for the sheep, either by dividing the field or having the hogs follow the sheep.

Surplus cereal and legume crops from the pastures can be cured into first-class winter roughage for sheep.

NOTE.—R. B. Millin, formerly employed by the Bureau of Animal Industry, assisted in the early development of the experiments reported in this bulletin.

¹ The occasional pasturing of a permanent crop like alfalfa is also employed in a system of temporary pastures.

ADVANTAGES OF TEMPORARY PASTURES

The use of temporary pastures aids in utilizing the economic peculiarities of sheep. This is true because a succession and a variety of fresh forage crops produce the maximum milk flow of the ewe, and lambs are largely a milk product. The lambs most in demand at the markets are those that reach a desirable weight and finish while still sucklings. Returns from the sale of such lambs are the quickest that can be obtained for a finished product in any line of livestock raising.

Permanent grass pastures are well suited to ewes with lambs, but as the lambs become larger and able to use more milk the feed is likely to be cut short by dry weather. Special seedings of annual crops at different dates give greater assurance of good milk-producing pasture when most needed. In most parts of the country, however, lambs can be marketed best before the usual date of dry weather.

On most high-priced lands a ewe's feed can be produced more cheaply from annual crops sown to be grazed than on permanent grass pasture. The extent to which the extra amount and value of the forage crop will offset the extra costs of fencing, plowing, and seeding depends upon the value of the land.

AID IN CONTROL OF PARASITES

An aid in controlling the ravages of stomach worms and other internal parasites is one of the advantages to be obtained by using temporary pastures for sheep. Losses by death or lack of thrift are most serious among lambs of flocks that are kept season after season on old grasslands. With only a few sheep on a large area of grass which is also pastured by other stock, the danger is less likely to be serious. With closer grazing by sheep during several months of each season the danger is increased and is most serious in sections or in seasons of high temperature and excessive moisture. Alternating permanent pastures during the season does not materially lessen the danger.

Though rotation of temporary pastures is a useful aid in diminishing the ravages of stomach worms, the plan requires that the flock does not go on a field a second time unless the land has been plowed in the interim or time enough has elapsed to cause the death of the stomach-worm larvae that left upon the field grazed by infected sheep.²

On farms provided with a large number of fields with fences suitable for sheep, a succession of clean temporary pastures can be

² Farmers' Bulletin 1330, "Parasites and Parasitic Diseases of Sheep."

provided. In most cases it is more economical and more satisfactory to provide permanent or movable fences for a number of smaller pasture lots, on each of which two or three crops can be grown each season to a stage suitable for grazing. On larger lots a system of hurdles can be used to permit access to a portion furnishing only 1 or 2 days' feed. It is more satisfactory to have lots of a size to furnish from 10 to 14 days' feed for the flock. Two weeks is the longest time that one piece of ground should be used during the warmer part of the season. Young lambs are most susceptible to injury from parasites, and are exposed to less danger when moved to fresh ground at intervals of not more than 2 weeks than when permitted to remain longer on the same fields.

IMPROVEMENT OF SOIL

An additional advantage in using temporary pastures for sheep raising is the improvement of the soil. The greatest demand upon fertility is avoided by not requiring the crops to mature seed. All the manure is distributed upon the ground together with all uneaten parts of the crop. With legume forages the gain to soil is especially valuable and allows production of still larger crops which are again returned to the land diminished only by the materials contained in the increased size of lambs or ewes while on that particular crop.

RESULTS OF EXPERIMENTS WITH TEMPORARY PASTURES

A study of the possibilities of sheep raising under a temporary pasture system was begun in 1916, when a field of 30 acres at the U. S. Animal Husbandry Experiment Farm at Beltsville, Md., was set aside to be used exclusively for sheep. The objects and results of the experiment relate to amount and value of pasturage; carrying capacity and value of various crops; health of sheep; size of lots and methods of fencing and grazing; effect on the land.

AMOUNT AND VALUE OF PASTURAGE

On the 30-acre field used in this experiment sufficient pasturage was produced to furnish an average of 505 days' grazing on each acre for a mature ewe. This is equivalent to about 2 sheep an acre for a season of 250 days, or $2\frac{1}{2}$ sheep for a 200-day period. This pasturage is much more than could be obtained from perennial grass grown on land of the character and value of that used in the experiment, but not more than can be obtained from the best blue-grass pastures. Good land used for such a succession of temporary pastures should produce from 50 to 100 per cent more pasturage than was obtained in this instance.

In a system like this there is not much choice of crops to be used in different months. It is chiefly necessary to make sure of having one crop ready when the preceding one is finished. All the crops used in 1919 stimulated a good flow of milk in the ewes, produced good growth in the lambs, and after weaning, put the ewes in good condition for fall breeding.

The ewes and lambs were all purebred Southdowns. Some of the ewes raising lambs received a half pound of grain each daily until May 10, and 22 head of ewes in a fall breeding experiment received a light feed of grain during September and October. All the lambs

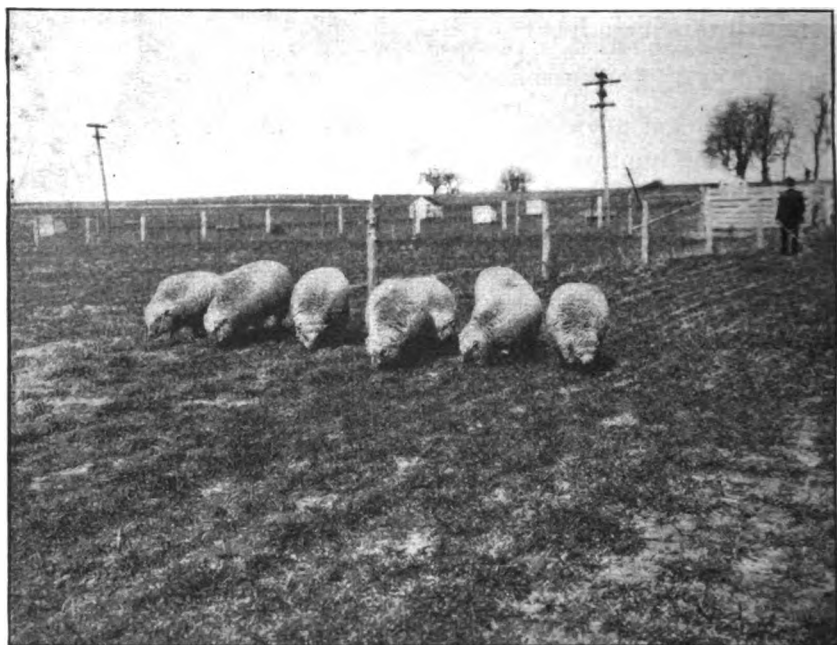


FIGURE 1.—Wheat is a very satisfactory spring forage. Yearling ewes on wheat at Beltsville, Md., March 16, 1917

were kept for breeding purposes and were fed some grain throughout the summer. In calculating how far the feed actually produced would go for grown sheep it was considered that a lamb ate one-fourth as much as a sheep until July 1, and after that one-half as much. Putting in the crops used in 1919 required 60 acres of plowing and seeding, a total of 520 hours' work for a man and a team.

Under the conditions of this experiment fall-sown wheat and spring seedings of oats and peas³ have been most satisfactory for grazing in spring and early summer. Soybeans are ready for grazing about the middle of July and furnish most of the feed until

³ Oats and field peas, sown together at the rate of 1½ bushels of each per acre.

October. In November fall-sown wheat and rye have been used most, though late seedings of corn and velvetbeans were used in 1919. The land is still too poor for rape, a good stand having been secured in 1919 for the first time on 11½ acres that had received an extra coating of manure.

Two crops were grown in 1919 on each forage lot. In the latitude of southern Maryland three crops can be raised on one-third the area where the land is used in the manner described.

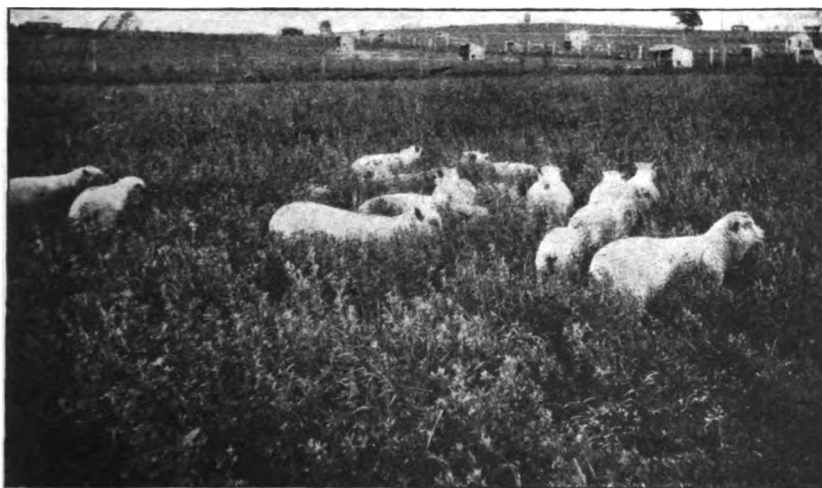


FIGURE 2.—Lambs in alfalfa, Beltsville, Md., July 7, 1917

CARRYING CAPACITY AND USE OF VARIOUS CROPS

The number of days of grazing from 1 acre of each crop in 1919 and the average for the 10-year period, 1920–1929, as calculated on pasture value for one mature ewe, are shown in the following table:

Days pasture per ewe, from different crops

Crop	Days pasture per ewe		Crop	Days pasture per ewe	
	1919	1920–1929		1919	1920–1929
Rape.....	392	388	Cowpeas.....	210	293
Soybeans.....	319	349	Alfalfa.....	882	1,030
Oats and peas.....	319	344	Barley.....	278	266
Wheat.....	309	265	Rye.....	180	186

Pasturing on wheat and rye began early in April in most cases and these forages continued suitable for use until about the middle of May. A second growth was usually grazed later by yearling or mature stock. Rye is not relished by the sheep so much as wheat,

and heads out more quickly. In this stage sheep do not eat either leaves or heads to the same extent that they eat wheat.

Rye is especially valuable for winter grazing in the Southern States. In winter-wheat sections that crop is grazed in winter and part of the spring with great advantage to the animals and to the grain crop as well.

Alfalfa was used in May and again, for ewes, in October. This crop does not fit well in a temporary pasture system on account of the likelihood of larvae left on the ground at one grazing infecting sheep at a later grazing. Cutting one crop for hay before the second grazing may reduce this danger, but does not wholly overcome it. Any such risk from feeding the cured hay would be slight.



FIGURE 3.—Ewes and lambs in rape, Beltsville, Md., June 20, 1917

Oats and peas grown together furnish most of the grazing, after using the wheat, until rape and soybeans are ready. The oats and peas may be sown early, and seedings at different dates insure later pasturage that is still succulent and tender.

It has been customary to plant this crop as soon as the land can be put in proper condition, which is about the first or second week in April. First pasturage is usually available late in May.

With rape, best results were obtained by planting during the first half of April. When planted later the crop was adversely affected by dry weather and became less palatable than earlier plantings. Rape has not been used extensively on the land described, owing to low fertility, but on rich land it may be the main forage crop from the time the first seeding is ready for use. Well-grown plants withstand a good deal of frost, and the crop should be useful for extending the grazing season late into the fall. Lambs require several days

to learn to eat rape readily, and it is an advantage if they can spend a few hours each day on some other crop until they have learned to like rape. Bloating rarely occurs in sheep pasturing on rape, but it is well to see them frequently during the first few days on this crop or in frosty weather. Rape ordinarily yields better and is grazed with less waste when planted in drills.

Soybeans have been used most extensively on this rotation of forage pastures. Early seedings were made late in April and May, later seedings through June and July and in some cases early August. Pasturing usually extended from early June until the first frost. Plantings throughout the summer make good growth. About five or six weeks should elapse between plantings and pasturing.



FIGURE 4.—Lambs in soybeans, Beltsville, Md., July 10, 1917

Early plantings will produce a second growth which will provide practically half as much additional forage as the first growth. This feature of making new growth after being grazed is a valuable one in soybeans, and sheep and lambs eat the crop with great relish.

Cowpeas are planted at the same time as soybeans and grow at about the same rate. They produce feed similar in amount to that obtained from soybeans, but are less palatable for lambs, and the crop does not make so much of a second growth as do soybeans. The arrangement of the fields used in this experiment, the order of seeding and grazing the crops, and the amount of pasturage produced are shown in the map of the field in figure 5.

HEALTH OF SHEEP

A reduction in injury caused by internal parasites results from providing temporary pastures for sheep under a plan that allows

their going to fresh ground at intervals of not more than 2 weeks. It is considered that most flocks have some degree of infection of stomach worms. In warm, moist weather the eggs in the droppings of the older sheep develop in a few days into larvae, which are especially injurious when taken up by lambs. These larvae are largely destroyed when land is plowed, and it is for this reason that plowing is recommended in reseeded land after a crop has been pastured.

Older sheep are less susceptible than lambs to the effects of stomach worms. There is less danger in allowing them to remain longer than 2 weeks on the same ground or in using up feed left in fields from which lambs have been removed. Because of the continued chance of infection of lambs from grass along fence rows and in unplowed yards and barn lots complete freedom from parasites is seldom obtained.

In pasturing ewes and lambs, in the experiments herein reported, stomach worms have not been found, except in a few cases in August and September, and these were overcome by giving the copper-sulphate treatment. In flocks changed to fresh ground every 2 weeks treatment would seldom be needed for lambs marketed in May and June. Temporary pastures on clean land are particularly useful for ewe lambs retained as breeders, though treatment for parasites would probably be advisable and may safely be used as a precautionary measure.⁴

The order in which various crops were used and the length of time spent upon each are shown before for the flock containing the young lambs and for the lambs alone after the time of weaning.

Order of grazing flock of ewes and lambs followed by lambs alone in experimental work

Date	Crop	Field No.	Acres in field	Number of lambs	Number of ewes
1919					
Apr. 8 to 19.....	Fall wheat.....	3	3	52	44
Apr. 20 to 26.....	Rye.....	6	3	52	44
Apr. 27 to May 8.....	Wheat.....	4	5.3	66	58
May 9 to 27.....	Alfalfa.....	8	2	66	58
May 28 to June 10.....	Oats and peas.....	5	5.8	66	56
June 11 to 17.....	do.....	(*)	3.7	66	56
June 18 to July 1.....	do.....	(*)		66	56
July 2 to 12.....	Rape.....	1	3	66	15
July 13 to 25.....	Soybeans.....	2	3	66	
July 26 to Sept. 11.....	do.....	3	3	62	
Sept. 12 to Oct. 10.....	do.....	6	3	(*)	
Oct. 11 to 25.....	Corn and velvet beans.....	9	2	59	
Oct. 26 to Nov. 5.....	Fall barley.....	5	5.8	(*)	
Nov. 6 to 25.....	Fall wheat.....	2 and 10	9	(*)	

* Part of 10.

* Other part of 10.

* Not grazed.

From April 17 to June 18, 14 dry and yearling ewes followed the ewes-and-lambs flock.

After July 2, the 70 ewes followed the lambs and also grazed Field 10, 3.7 acres soybeans, and Field 4, 5.3 acres corn and soybeans.

* Medicinal treatment for stomach worms is described in Farmers' Bulletin 1330.

SIZE OF LOTS AND METHODS OF FENCING AND GRAZING

The convenient size for temporary pasture lots is determined mainly by the size of the flock. For health and for economical use of the pasturage it is undesirable to keep sheep on the same ground more than from 10 to 14 days. A useful size of lot is 1 acre to 25 sheep. This area on an average furnished 14 days' feed.

Arranging the size of lots on the basis of 1 acre to 25 sheep is more satisfactory than seeding larger areas and using hurdles to permit advance to fresh feed each day. Less labor is necessary and by going to entirely new ground after 10 to 12 days the danger of picking up parasite larvae on ground grazed over earlier is prevented. With a 1-acre lot for 25 ewes or correspondingly larger lots for larger flocks it is an added advantage if the length is two or three times the breadth. With a heavy crop of forage that would last longer than was considered safe to hold the flock on the same ground, a short piece of cross fencing can readily be used to divide the pasture into two parts. The smaller lots are also convenient with purebred flocks to provide for separate pasturing of smaller lots of ram and ewe lambs.

Movable fencing is not likely to be satisfactory for the outside-lot fences unless the whole area to be used lies in a long strip with side fences, when only two end pieces need to be in place at one time for the ground being grazed.

A handy style of movable fence consists of a roll of 32-inch woven wire supported by posts made of half-inch iron rods. This post is known as the Illinois post.⁵ Eight inches from the foot there is a branch at right angles to the post. This branch runs out 6 or 8 inches and turns downward parallel with the post itself. This post can be set readily by pressing on the branch with the foot. The shape of the bottom part gives bracing enough to prevent pushing over by the sheep. The bottom of the fence is kept in place by passing the post between two of the lower wires. The top wire lies in a groove made in the top of the post.

EFFECT ON THE LAND

During the period 1916-1919 the carrying capacity of the land on which these experiments with temporary pastures were conducted was increased 100 per cent. Increases in carrying capacity for most of the crops have continued throughout the following 10-year period, 1920-1929.

The data on page 5 show the carrying capacity of the various crops throughout the two periods. The increase is about 15 per cent over the 1919 production for all crops except winter wheat, winter barley,

⁵ The Illinois post and other kinds of equipment for sheep raisers are illustrated and described in Farmers' Bulletin 810, Equipment for Farm Sheep Raising.

and rape. The reduction in carrying capacity for wheat and barley was largely due to the quantities of these crops not utilized for pasture, as the practice has been to turn the stock on to some of the other more palatable feeds as soon as they were available.

The field is a low-lying, flat piece of land decidedly below average fertility. The results obtained are far below what would be secured on many farms, and demonstrate the advantages and general style of practicing such a system rather than maximum quantity of feed which can be produced. Improvement in soil condition has been due to the manure left distributed upon the land by the sheep, to the plowing in of unused parts of crops, and to other beneficial effects of legume crops, soybeans in particular. In order to get satisfactory crops of cowpeas and soybeans 40 tons of ground limestone and 2 tons of acid phosphate in all were applied to 25 acres of the field in the fall of 1916 and in 1917. During the three seasons 1918 to 1920, inclusive, 15 acres also received a single application of manure at the rate of 10 tons of fresh manure per acre.

The soil is too heavy to be benefited by trampling; in fact holding the sheep on the lots in wet times has had a harmful effect. The sheep were kept night and day upon the crop in use without access to any other pasturage. Shade and water were provided in each lot.

FORAGE ROTATIONS FOR DIFFERENT SECTIONS

Although the crops described seem best adapted to the section near Washington, in which the farm is situated, it does not follow that they would be best for sections in which climatic conditions are very dissimilar. For instance, in New York and the New England States, rye, oats and field peas, and rape should form the principal part of the rotation, with alfalfa or permanent pasture to fill the gap between rye and oats and field peas, the last two being grown together. Plantings of rape following both of the crops would furnish feed in the autumn as long as the sheep could be left out.

In the South Atlantic and Gulf Coast States a greater variety of forage crops is available. The following table indicates groups from which selection could be made, together with the months in which they would be most desirable for sheep pasturage.

Group	Crops	Time available for pasturing
1	Wheat, oats, rye, Italian rye grass, or rape	Jan. 1 to Apr. 30.
2	Lespedeza, Bermuda grass, carpet grass, ripe oats, alfalfa	Mar. 1 to June 30.
3	Early varieties of soybeans and cowpeas	June 1 to July 30.
4	Late varieties of soybeans, cowpeas, velvet beans, sorghum, and millet	July 1 to Nov. 30.
5	Winter rye, oats, barley, wheat, and rape	Oct. 15 to Dec. 31.

¹ Group 2 could be cut later for hay.

Group 2 consists of meadow or permanent pasture plants which could be pastured for a few weeks each spring without danger of serious infection from stomach worms. The choice of the crops from each of these groups should depend upon the degree of success with which they are grown in any particular section.

Supplementary literature may be found in the following Farmers' Bulletins: 690, Field Peas as a Forage Crop; 756, Rye Culture in Eastern States; 1148, Culture and Varieties of Cowpeas; 1276, The Velvet Bean; 1283, How to Grow Alfalfa; 1467, Commercial Varieties of Alfalfa; 1520, Soybeans: Culture and Varieties; 1581, Oats in the North Central States; 1583, Spring Sown Red Oats.

ROTATIONS WITH PERMANENT PASTURES, STUBBLE FIELDS, AND TEMPORARY PASTURES

When it is not practicable to use a system of temporary pastures to provide the change of pasture necessary for protection from parasites, an effective system can be arranged in the regular crop fields of most stock farms, provided there is a sufficient number of fields having sheep fence. It is necessary that the lambs, and so far as possible the ewes, should be moved to new pasturage at intervals of not longer than 2 weeks without returning to any land that has not been plowed since it was grazed by sheep. In freezing weather these frequent changes are not required from a health point of view.

In a plan of providing a change of pastures in a stock-farm crop rotation, the earliest grazing is furnished by fall-sown wheat or rye. This can be used for 2 weeks in freezing weather even though the crop has been grazed previously during the winter. Following this, the flock is placed on permanent grass pasture upon which there were no sheep during the previous year. If the second, or grass pasture, free from infection, is not available, a red-clover crop is used. Ordinarily this would be the same land upon which the sheep grazed wheat at the beginning of the previous year. In most sections the danger of infection in such case would not be a serious one. By the time the third change is necessary some clover fields have usually been harvested for hay and the second growth can be used for grazing. At this time of year (early fall) on farms producing such crops as mentioned for other livestock, lambs will usually be marketed. The ewes, if necessary, can return to some of the same land previously used. This does not allow the same degree of protection from parasites as would exist if there were no pasturing the second time without intervening plowing, but the effects of the parasite are less serious in older sheep, and treatment can be given to those ewes that show the need of it, to prevent a serious setback.

FIELD 1.-3 ACRES RAPE 69 ewes } June 18 to 28 14 lambs } 66 lambs } July 2 to 12 70 ewes } July 12 to 16 25 ewes } Aug. 29 to Sept. 15 MILLET 25 ewes } Aug. 29 to Sept. 15 13 ewes } Sept. 13 to Oct. 20	FIELD 10. 3.7 ACRES OATS AND PEAS 56 ewes } June 11 66 lambs } to 17 15 ewes } June 18 64 lambs } to July 1 70 ewes } July 2 to 6 SOY BEANS 34 ewes } Sept. 15 to Oct. 8 30 ewes } Nov. 10 to 24.	FIELD 9. 2 ACRES COW PEAS 70 ewes } July 7 to 12 CORN AND VELVET BEANS 59 lambs } Oct. 11 to 25 33 ewes } Oct. 29 to Nov. 5	FIELD 8. 2 ACRES ALFALFA 53 ewes } May 9 66 lambs } to 27 ALFALFA 25 ewes } Sept. 6 to Oct. 10
FIELD 2.-3 ACRES SOY BEANS 66 lambs } July 12 to 26 70 ewes } July 26 to Sept. 15 35 ewes } Aug. 29 to Sept. 15 WHEAT 24 lambs } Nov. 4 to 25		FIELD 7.-2 ACRES RYE 9 ewes } Apr. 8 to 14 11 yearlings } 9 ewes } Apr. 14 to 21 9 yearlings } 7 ewes } Apr. 21 to 27 9 yearlings }	
FIELD 3.-3 ACRES. WHEAT 44 ewes } April 7 to 20 52 lambs } 15 ewes } April 27 to May 21 SOY BEANS 62 lambs } July 26 to Sept. 1 35 ewes } Sept. 2 to 14	FIELD 6.-3 ACRES RYE 12 ewes } April 11 to 26 9 lambs } 44 ewes } April 21 to 27 52 lambs } 14 ewes } May 20 to 27 SOY BEANS 60 lambs } Sept. 11 to Oct. 10 25 ewes } Oct. 11 to 15		
FIELD 4.-5.3 ACRES WHEAT 53 ewes } April 27 to May 8 66 lambs } 14 ewes } May 28 to June 17 69 ewes } June 27 to July 1 CORN AND SOY BEANS 33 ewes } Oct. 9 to 29	FIELD 5.-5.8 ACRES OATS AND PEAS 53 ewes } May 28 to June 10 66 lambs } 70 ewes } July 15 to 26 BARLEY 26 ewes } Oct. 15 to 27 54 lambs } Oct. 25 to Nov. 6.		

FIGURE 5.—Diagram showing the rotation of crops and the amount of grazing afforded by each field on the specialized sheep farm at Beltsville, Md., 1919

For ewes or for lambs that are carried later in the year, later pasturage is furnished in the stubble fields of the grain crops, and after that from rape sown in the cornfields. At a still later time the early fall-sown grain furnishes pasturage until the coming winter.

One or two acres of rape or some other forage crop will usually be found desirable as an insurance against possible shortage of pasturage in other fields, and more particularly as a safe and satisfactory feed for ewe lambs retained for breeding, and which can not safely remain with the ewes, particularly if the latter are spending part of their time upon land that may be infected.

SPECIALIZED SHEEP FARMING

At present farms devoted mainly to sheep raising are not numerous. The opportunity exists for specializing in sheep raising with the same prospects of profit as are to be obtained from specializing in other lines of livestock production. In a plan of specialized sheep raising larger reliance necessarily would be placed upon temporary pastures. The results of experiments reported in this bulletin demonstrate that with the rotation of grazing and plowing for reseeding, land can be stocked heavily with sheep year after year without the development of serious difficulties. The necessary winter feed for a specialized sheep farm can be produced in connection with the regular temporary pastures. Extra seedings of leguminous crops can be harvested for hay, and in most seasons there is likely to be a part of some crop which is not needed for pasturing and can be cured for winter feeding. With the production of silage for a part of the roughage fed in winter the amount of land required is reduced to a minimum.

MOST SUITABLE SOILS

Land suitable for a system of this kind should be level or only slightly rolling, and of a rather heavy soil texture in order that it will not wash readily with the plowing necessary to provide the maximum amount of pasturage and protection from parasites.

PROTECTION FROM DOGS

One of the principal drawbacks to sheep raising in the Eastern States is the damage done by sheep-killing dogs. Practical protection may be had in this system of farming by making the outside fence dog proof.⁶ The construction of a fence of this sort, although practically impossible on lands generally used as sheep pastures, is easily accomplished with little additional expense in level-lying lands.

⁶ See Figure 29, Farmers' Bulletin 810, Equipment for Farm Sheep Raising.

DISTRIBUTION OF LABOR

Labor is one of the principal problems in carrying on many agricultural projects. It is necessary for the farmer to arrange his work so that he will be able to give constant employment to all his men.

Specialized sheep farming offers the advantage of more even distribution of labor throughout the year than most other forms of specialized farming. There is no particular rush season, as the lambing season is over before the land is ready for spring planting. Other plantings are necessarily made from time to time throughout the summer in order that fresh pasturage may be available at all times. Such harvesting as must be done comes at different times throughout the year when feed is available for cutting.

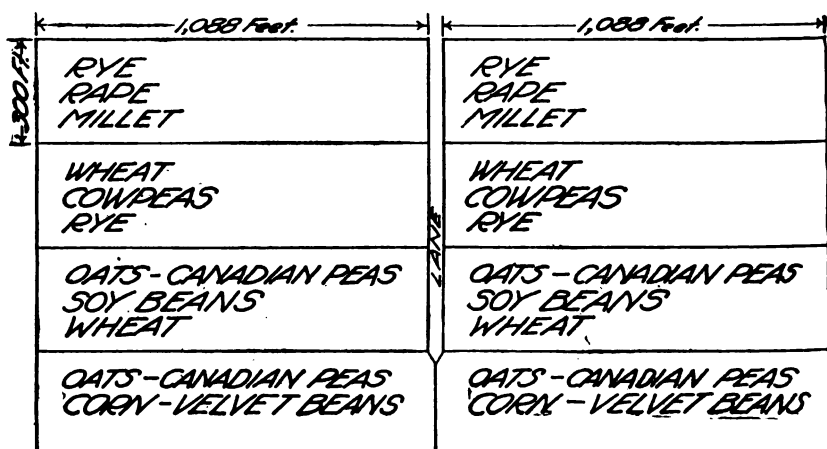


FIGURE 6.—Diagram of a farm showing a practical rotation of crops for each field for Central Atlantic and Corn Belt States

Figure 6 shows a model farm plan for specialized sheep raising, and indicates a practical rotation of crops for each field for Central Atlantic and Corn Belt States.

U. S. DEPARTMENT OF
AGRICULTURE

FARMERS' BULLETIN No. 1181

RAISING SHEEP
ON TEMPORARY
PASTURES



TEMPORARY pastures for sheep may be used for all or part of the grazing season. Their use makes it possible to fit the flock into the livestock farming system with very little change in the usual methods of producing feed and pasturage for cattle and swine.

By using temporary pastures the flockmaster is able to maintain a uniform milk flow of the ewes, which insures rapid development of the lambs to market size.

The use of temporary pastures assists greatly in the prevention of infection by stomach worms and other internal parasites. Frequent changes to new pasturage can be made and losses by death and lack of thrift prevented.

A system of temporary pastures for sheep raising permits the use of lands of low fertility and at the same time insures a revenue from them without an expensive outlay for commercial fertilizer. Only lime, phosphorus, and inoculating material are necessary to enable poor soils to produce legumes.

This bulletin explains the advantages and methods of using temporary pastures for sheep and gives results of experiments conducted at the Animal Husbandry Experiment Station, Beltsville, Md.

Washington, D. C.

Issued March 1921
Revised April 1939

RAISING SHEEP ON TEMPORARY PASTURES

By C. G. PORTS, *animal husbandman*, and V. L. SIMMONS, *assistant animal husbandman*, *Animal Husbandry Division, Bureau of Animal Industry*

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CROPS USED FOR TEMPORARY PASTURES

ANY ANNUAL CROPS that are sown for the purpose of being pastured off before maturity are called temporary pastures.¹ They may be used as the sole pasture crop for all or for a part of the grazing season. Their use as pasture for sheep fits into the livestock farming system with very little change in the usual methods of producing feed and pasturage for cattle and swine. The carrying capacity and value of the following crops are discussed in this bulletin: Fall-sown wheat, rye, and barley, and alfalfa, spring-sown oats and peas, rape, cowpeas, Italian ryegrass, soybeans, and corn and velvet beans.

In many localities fall wheat or rye is grazed during the winter and early spring and then allowed to mature a grain crop. The same practice is possible with spring-sown cereals, but is less often practicable with cowpeas and soybeans. The temporary pasture crops suitable for sheep are equally valuable for hogs. In case a crop is to be used for both kinds of stock the feed should be kept fresh for the sheep, either by dividing the field or having the hogs follow the sheep.

Surplus cereal and legume crops from the pastures can be cured into first-class winter roughage for sheep.

ADVANTAGES OF TEMPORARY PASTURES

The use of temporary pastures aids in utilizing the economic peculiarities of sheep. This is true because a succession of a variety of fresh forage crops produces the maximum milk flow in the ewe, and lambs are largely a milk product. The lambs most in demand at the markets are those that reach a desirable weight and finish

¹ The occasional pasturing of a permanent crop like alfalfa is also advisable in a system of temporary pastures.

while still sucklings. Returns from the sale of such lambs are the quickest that can be obtained for a finished product in any line of livestock raising.

Permanent grass pastures are well suited to ewes with lambs, but as the lambs become larger and able to use more milk the feed is likely to be cut short by dry weather. Special seedings of annual crops at different dates give greater assurance of good milk-producing pasture when most needed. In most parts of the country, however, lambs can be marketed best before the usual date of dry weather.

On most high-priced lands a ewe's feed can be produced more cheaply from annual crops sown to be grazed than on permanent grass pasture. The extent to which the extra amount and value of the forage crop will offset the extra costs of fencing, plowing, and seeding depends upon the value of the land.

AID IN CONTROL OF PARASITES

An aid in controlling the ravages of stomach worms and other internal parasites is one of the advantages to be obtained by using temporary pastures for sheep. Losses by death or lack of thrift are most serious among lambs of flocks that are kept season after season on old grasslands. With only a few sheep on a large area of grass which is also pastured by other stock, the danger from stomach worms is less likely to be serious. With closer grazing by sheep during several months of each season the danger is increased and is most serious in sections or in seasons of high temperature and excessive moisture. Alternating permanent pastures during the season minimizes but does not eliminate the danger of infestation.

Though rotation of temporary pastures is a useful aid in diminishing the ravages of stomach worms, the plan requires that the flock should not go on a field a second time unless the land has been plowed in the interim or time enough has elapsed to cause the death of the stomach worm larvae that have been left upon the field grazed by infected sheep.²

On farms provided with a large number of fields with fences suitable for sheep, a succession of clean temporary pastures can be provided. In most cases it is more economical and more satisfactory to provide permanent or movable fences for a number of smaller pasture lots, on each of which two or three crops can be grown each season to a stage suitable for grazing. On larger lots a system of hurdles can be used to permit access to a portion furnishing only 1 or 2 days' feed. It is more satisfactory to have lots of a size to furnish from 10 to 14 days' feed for the flock. Two weeks is the longest time that one piece of ground should be used during the warmer part of the season. Young lambs are most susceptible to injury from parasites and are exposed to less danger when moved to fresh ground at intervals of not more than 2 weeks than when permitted to remain longer on the same fields.

IMPROVEMENT OF SOIL

An additional advantage in using temporary pastures for sheep raising is the improvement of the soil. The greatest demand upon

² Farmers' Bulletin 1330, Parasites and Parasitic Diseases of Sheep.

fertility is avoided by not requiring the crops to mature seed. All the manure is distributed upon the ground together with all uneaten parts of the crop. With legume forages the gain to soil is especially valuable and allows production of still larger crops, which are again returned to the land, diminished only by the materials utilized by the lambs or ewes while on that particular crop.

VALUE AND USE OF TEMPORARY PASTURES

In raising sheep under a temporary pasture system there is not much choice of crops to be used in different months. It is chiefly necessary to make sure of having a crop ready when the preceding one is finished. In the Middle Atlantic States, fall-sown wheat, rye, and barley, followed by spring-sown oats and peas, soybeans, and fall seedings of the previously mentioned cereal crops, are usually quite satisfactory in a rotation of crops that will furnish continuous grazing from April to November. All of these crops are of value in stimulating a good flow of milk in the ewes; they produce good growth in the lambs and put the ewes in good condition for breeding after the lambs are weaned. It is sometimes an added advantage to allow the ewes that are raising lambs one-half to three-fourths of a pound of grain each, daily, until the lambs are weaned. All lambs kept for breeding purposes should be fed some grain throughout the summer. Also a light feed of grain given to the ewes while on pasture during September and October will tend to put them in a gaining condition during the breeding season, and prove economical in the case of a scarcity of pasture.

CARRYING CAPACITY AND USE OF VARIOUS CROPS

Studies of the carrying capacities of various crops used as temporary pastures for sheep have been made at the Animal Husbandry Experiment Station, Beltsville, Md. In determining how far the feed furnished by temporary pasture crops will actually go for mature sheep, allowance is made for the lambs. It is considered that a lamb will eat one-tenth as much pasture in March, when about 6 weeks old, as a sheep, and an additional one-tenth each month thereafter throughout the grazing season.

During an 18-year period sufficient pasturage was produced on each acre of temporary pasture to furnish one mature ewe with an average of 321 days of grazing. This is equivalent to a rate of stocking of slightly more than one and one-half sheep an acre for a 200-day period. Fertile land in a high state of cultivation should produce 50 to 100 percent more pasturage than that obtained in these studies.

The average number of days of grazing from 1 acre of each crop during the 18-year period, as calculated on the pasture value for one mature ewe, is shown in table 1.

Fall-sown wheat and barley, and spring seedings of oats and peas are very satisfactory for grazing in spring and early summer. Pasturing on wheat and barley starts early in April in most cases and these forages continue suitable for use until about the middle of May. Barley is particularly well adapted for late fall pasture and it is relished by sheep.

Wheat makes excellent pasture for sheep, and if the pasture is managed carefully a large quantity of feed may be obtained. Because of their varied growing habits, wheat and rye grown together are especially suitable for supplementing permanent pastures in the early spring. The rye tends to keep the wheat from winter killing, and the wheat produces palatable feed much later in the spring.

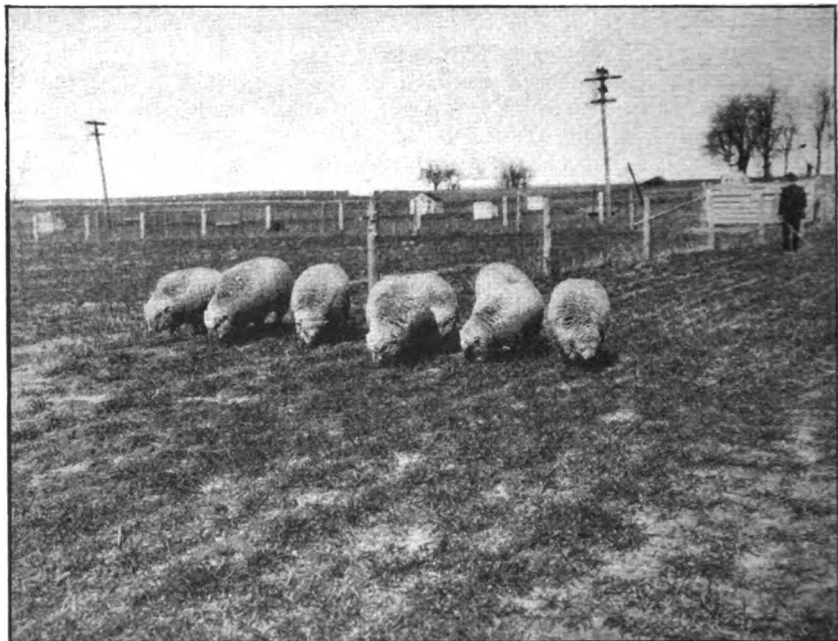


FIGURE 1.—Wheat is a very satisfactory spring forage. Yearling ewes on wheat at Beltsville, Md., March 16.

Rye planted alone is not relished by sheep so much as is wheat, and rye heads out more quickly. In this stage sheep do not eat either leaves or heads to the same extent that they eat wheat. To get the most out of rye with ewes and lambs it must be kept closely grazed. Barley and rye grown together furnished a fair amount of late fall and early spring pasture.

Rye is especially valuable for winter grazing in the Southern States. In winter-wheat sections wheat is grazed in winter and part of the spring with great advantage to the animals and to the grain crop as well.

After the above crops, oats and Canada field peas grown together furnish most of the grazing until soybeans are ready. The oats and peas may be sown early, and seedings at different dates insure pasturage that is still succulent and tender until soybeans are available.

Rape is well known as a forage crop for sheep and lambs. It is hardy and therefore suitable for sowing in April or early spring. When planted later, the crop may be adversely affected by dry weather and become less palatable than earlier plantings. Rape is adapted to a fertile soil and a plentiful supply of moisture. Well-grown plants

withstand considerable frost, and the crop should be useful for extending the grazing season late into the fall.

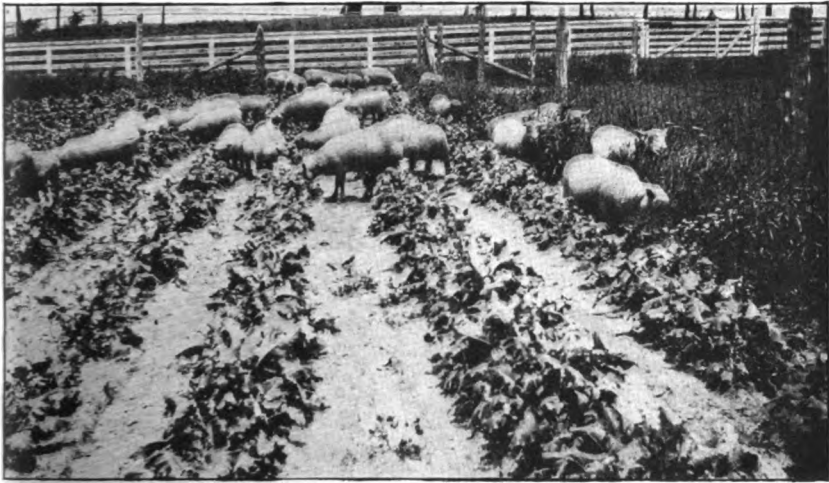


FIGURE 2.—Ewes and lambs in rape, Beltsville, Md., June 20.

Lambs require several days to learn to eat rape readily, and it is an advantage if they can spend a few hours each day in some other crop until they have learned to like rape. Bloating rarely occurs in sheep pasturing on rape, but it is well to inspect them frequently during the first few days on this crop or in frosty weather. Rape has considerable fattening ability and can be used to advantage in finishing lambs for the market. This crop ordinarily yields better and is grazed with less waste when planted in drill rows.



FIGURE 3.—Lambs in soybeans, Beltsville, Md., July 10.

Soybeans are ready for grazing about the middle of July and furnish excellent feed until October. Early seedings may be made in April

and May and later seedings through June and July and in some seasons early August. Plantings should be ready for pasturing about 7 or 8 weeks after they are sown.

TABLE 1.—*Days of pasture per ewe, from different crops*

Crop	Years grown	Pasture per ewe	Crop	Years grown	Pasture per ewe
	<i>Number</i>	<i>Days</i>		<i>Number</i>	<i>Days</i>
Alfalfa.....	2	536	Wheat.....	7	278
Italian ryegrass.....	3	534	Barley.....	11	259
Rape.....	3	392	Rye.....	10	243
Soybeans.....	18	354	Wheat and barley.....	4	387
Corn and velvetbeans.....	12	337	Wheat and rye.....	6	318
Oats and peas.....	17	318	Barley and rye.....	4	208
Cowpeas.....	3	301	Permanent pasture.....	18	716

If not pastured too heavily, early plantings will produce a second growth that will provide practically half as much additional forage as the first growth. This feature of making new growth after being grazed is a valuable one in soybeans, and sheep and lambs eat the crop with great relish. When sown in corn, soybeans serve as an excellent supplement to the corn for fattening lambs in cornfields.

Cowpeas are planted at the same time of year as soybeans and grow at about the same rate. Cowpeas produce about as much feed as soybeans but are less palatable for lambs and require a warmer climate, and the crop does not make so much second growth as do soybeans. In some sections of the Middle West lamb feeders have made good use of cowpeas by planting them in the corn, thus producing more forage that remains green until frost.

Velvetbeans furnish good grazing for sheep. On account of the long vines, it is necessary to grow them in conjunction with some supporting crop. Velvetbeans can be planted to greatest advantage with corn. If the velvetbeans are planted at the same time as or after the corn, usually they do not begin to run until the corn is well grown. Combining the two crops increases the quantity of feed per acre and prolongs the period of grazing longer than corn with soybeans or cowpeas can be grazed.

Alfalfa may be used as sheep pasture in the spring and in the fall. Except for its tendency to cause bloating, it is a good feed for sheep and lambs. Danger of bloating is greatest when the alfalfa is wet. The sheep should not be turned onto alfalfa when they are very hungry. Neither should they feed long at a time on this crop during its first few days of growth. Because it is so watery while very young alfalfa has the highest feeding value when the plants are above 6 inches in height. Alfalfa does not fit well in a temporary pasture system because the interval between grazings is not sufficient to eliminate the infective larvae of internal parasites that may be present as a result of previous infestation. Cutting one crop for hay before the second grazing may reduce this danger, but does not wholly eliminate it. The risk from feeding the cured hay would be slight.

Italian ryegrass pasture is relished by all classes of livestock. Italian ryegrass is a short-lived, rapid-growing perennial, and although not widely used in the Atlantic Coast States it is adapted to these sections. It is a very early crop, and the seed falls readily when mature, so that

it reseeds itself freely. It may be sown in the fall or spring. In the South Atlantic States fall seeding gives the most satisfactory results.

COMBINATION PASTURE CROPS

The object of making mixtures of leguminous crops or cereal grains for sheep pastures is largely to increase the yield and quality of the feed. Canadian peas added to spring-sown oats, for example, improve the quality of the crops, whereas the oats provide a means of keeping the peas erect and prevent loss from trampling. At Beltsville combination crops of wheat with either rye or barley produced approximately 35 percent more grazing than any of these crops grown alone (table 1).



FIGURE 4.—Lambs in alfalfa, Beltsville, Md., July 7.

HEALTH OF SHEEP

Injury caused by internal parasites may be reduced by providing temporary pastures for sheep under a plan that allows them to go to fresh ground at intervals of not more than 2 weeks. Most flocks have some degree of infection of stomach worms. In warm, moist weather the eggs in the droppings of the older sheep develop in a few days into larvae, which are especially injurious when taken up by lambs. Some of these larvae may die when land is plowed, and it is for this reason that plowing is recommended on reseeded land after a crop has been pastured.

Older sheep are less susceptible than lambs to the effects of stomach worms. There is less danger in allowing them to remain longer than 2 weeks on the same ground or in using up feed left in fields from which lambs have been removed. Because of the continued chance of infection of lambs from grass along fence rows and in unplowed yards and barn lots complete freedom from parasites is seldom obtained.

In pasturing ewes and lambs on temporary pastures stomach worms may be kept well under control until August or September. However,

during the summer months it is advisable to give the sheep medicinal treatment as a further means of control.³ In flocks changed to fresh ground every 2 weeks treatment should seldom be needed for lambs marketed in May and June. Temporary pastures on clean land are particularly useful for ewe lambs retained as breeders, though treatment for parasites would probably be advisable as a precautionary measure.

SIZE OF LOTS AND METHODS OF FENCING AND GRAZING

The convenient size for temporary pasture lots is determined mainly by the size of the flock. For health and for economical use of the pasturage it is undesirable to keep sheep on the same ground more than from 10 to 14 days. A useful size of lot is 1 acre to 25 sheep. This area on an average furnished 14 days' feed.

Arranging the size of lots on the basis of 1 acre to 25 sheep is more satisfactory than seeding larger areas and using hurdles to permit advance to fresh feed each day. Less labor is necessary, and by going to entirely new ground after 10 to 12 days the danger of picking up parasite larvae on ground grazed over earlier is prevented. With a 1-acre lot for 25 ewes or correspondingly larger lots for larger flocks it is an added advantage if the length is two or three times the breadth. With a heavy crop of forage that would last longer than was considered safe to hold the flock on the same ground, a short piece of cross fencing can readily be used to divide the pasture into two parts. The smaller lots are also convenient with purebred flocks to provide for separate pasturing of smaller lots of ram and ewe lambs.

Movable fencing is not likely to be satisfactory for the outside-lot fences unless the whole area to be used lies in a long strip with side fences, when only two end pieces need to be in place at one time for the ground being grazed.

A handy style of movable fence consists of a roll of 32-inch woven wire supported by posts made of half-inch iron rods. This post is known as the Illinois post.⁴ Eight inches from the bottom there is a branch at right angles to the post. This branch runs out 6 or 8 inches and turns downward parallel with the post itself. This post can be set readily by pressing on the branch with the foot. The shape of the bottom part gives bracing enough to prevent the sheep from pushing the fence over. The bottom of the fence is kept in place by passing the post between two of the lower wires. The top wire lies in a groove made in the top of the post.

EFFECT ON THE LAND

The use of a system of temporary pastures in sheep raising has certain advantages. Improvement in soil fertility is accomplished through the manure distributed on the land by the sheep, by the plowing in of unused parts of crops, and through other beneficial effects of legume crops, soybeans in particular. If the land is below average in fertility the application of either commercial fertilizer or manure may be essential to the production of satisfactory crops.

³ Medicinal treatment for stomach worms is described in Farmers' Bulletin 1330, *Parasites and Parasitic Diseases of Sheep*.

⁴ The Illinois post and other kinds of equipment for sheep raisers are illustrated and described in *Farmers' Bulletin 810, Equipment for Farm Sheep Raising*.

The type of soil on which temporary pasture crops are grown will govern somewhat the manner in which they can be grazed. If the soil is very heavy it will not be benefited by trampling; in fact holding the sheep on the lots in wet weather will have a harmful effect. If it is necessary to keep the sheep upon a crop night and day it is essential that shade and water be provided in the lot.

FORAGE ROTATIONS FOR DIFFERENT REGIONS

Although the crops described herein seem best adapted to the Middle Atlantic States, it does not follow that they would be best for regions in which climatic conditions are very dissimilar. For instance, in New York and the New England States, rye, oats and field peas, and rape should form the principal part of the rotation, with alfalfa or permanent pasture to fill the gap between rye and oats and field peas, the last two being grown together. Plantings of rape following both of the crops would furnish feed in the autumn as long as the sheep could be left out.

In the South Atlantic and Gulf Coast States a greater variety of forage crops is available. Table 2 indicates groups from which selection could be made, together with the months in which they would be most desirable for sheep pasturage.

TABLE 2.—*Grazing periods of different crops*

Group	Crops	Time available for pasturing
1	Wheat, oats, rye, Italian ryegrass, or rape.....	Jan. 1 to Apr. 30.
2	Lespedeza, Bermuda grass, carpet grass, ripe oats, alfalfa.....	Mar. 1 to June 30.
3	Early varieties of soybeans and cowpeas.....	June 1 to July 30.
4	Late varieties of soybeans, cowpeas, velvetbeans, sorghum, and millet.....	July 1 to Nov. 30.
5	Winter rye, oats, barley, wheat, and rape.....	Oct. 15 to Dec. 31.

¹ Group 2 could be cut later for hay.

Group 2 consists of meadow or permanent pasture plants which could be pastured for a few weeks each spring without danger of serious infection from stomach worms. . . The choice of the crops from each of these groups should depend upon the degree of success with which they are grown in any particular region.

Supplementary literature on the production of various forage crops may be obtained by consulting lists of Department publications or agricultural extension workers.

ROTATIONS WITH PERMANENT PASTURES, STUBBLE FIELDS AND TEMPORARY PASTURES

When it is not practicable to use a system of temporary pastures to provide the change of pasture necessary for protection from parasites, an effective system can be arranged in the regular crop fields of most stock farms provided there is a sufficient number of fields having sheep fence. It is necessary that the lambs, and so far as possible the ewes, should be moved to new pasturage at intervals of not longer than 2 weeks without returning to any land that has not been plowed since it was grazed by sheep. In freezing weather these frequent changes are not necessary from a health point of view.

In a plan of providing a change of pastures in a stock-farm crop rotation, the earliest grazing is furnished by fall-sown wheat or rye. This can be used for 2 weeks in freezing weather even though the crop has been grazed previously during the winter. Following this, the flock is placed on permanent grass pasture upon which there were no sheep during the previous year. If the second, or grass pasture, free from infection, is not available, a red clover crop is used. Ordinarily this would be the same land upon which the sheep grazed wheat at the beginning of the previous year. In most sections the danger of infection in such case would not be a serious one. By the time the third change is necessary some clover fields have usually been harvested for hay and the second growth can be used for grazing. At this time of year (early fall) on farms producing such crops as mentioned for other livestock, lambs will usually be marketed. The ewes, if necessary, can return to some of the land previously used. This does not allow the same degree of protection from parasites as would exist if there were no pasturing the second time without intervening plowing, but the effects of the parasite are less serious in older sheep, and treatment can be given to those ewes that show the need for it, to prevent a serious setback.

For ewes or for lambs that are carried later in the year, later pasturage is furnished in the stubble fields of the grain crops, and after that from rape sown in the cornfields. At a still later time the early fall-sown grain furnishes pasturage until the coming winter.

One or two acres of rape or some other forage crop will usually be found desirable as insurance against possible shortage of pasturage in other fields, and more particularly as a safe and satisfactory feed for ewe lambs retained for breeding, and which cannot safely remain with the ewes, particularly if the latter are spending part of their time upon land that may be infected.

SPECIALIZED SHEEP FARMING

At present farms devoted mainly to sheep raising are not numerous. The opportunity exists for specializing in sheep raising with the same prospects of profit as are to be obtained from specializing in other lines of livestock production. In a plan of specialized sheep raising larger reliance necessarily would be placed upon temporary pastures. The results of experiments reported in this bulletin demonstrate that with the rotation of grazing and plowing for reseeding, land can be stocked heavily with sheep year after year without the development of serious difficulties. The necessary winter feed for a specialized sheep farm can be produced in connection with the regular temporary pastures. Extra seedings of leguminous crops can be harvested for hay, and in most seasons there is likely to be a part of some crop which is not needed for pasturing and can be cured for winter feeding. With the production of silage for a part of the roughage fed in winter the amount of land required is reduced to a minimum.

MOST SUITABLE SOILS

Land suitable for a system of this kind should be level or only slightly rolling, and of a rather heavy soil texture in order not to wash

readily with the plowing necessary to provide the maximum amount of pasturage and protection from parasites.

PROTECTION FROM DOGS

One of the principal drawbacks to sheep raising in the Eastern States is the damage done by sheep-killing dogs. Practical protection may be had in this system of farming by making the outside fence dogproof.⁵ The construction of a fence of this sort, although practically impossible on lands generally used as sheep pastures, is easily accomplished with little additional expense in level-lying lands.

DISTRIBUTION OF LABOR

Labor is one of the principal problems in carrying on many agricultural projects. It is necessary for the farmer to arrange his work so that he will be able to give constant employment to all his men.

Specialized sheep farming offers the advantage of more even distribution of labor throughout the year than most other forms of specialized farming. There is no particular rush season, as the lambing season is over before the land is ready for spring planting. Other plantings are necessarily made from time to time throughout the summer in order that fresh pasturage may be available at all times. Such harvesting as must be done comes at different times throughout the year when feed is available for cutting.

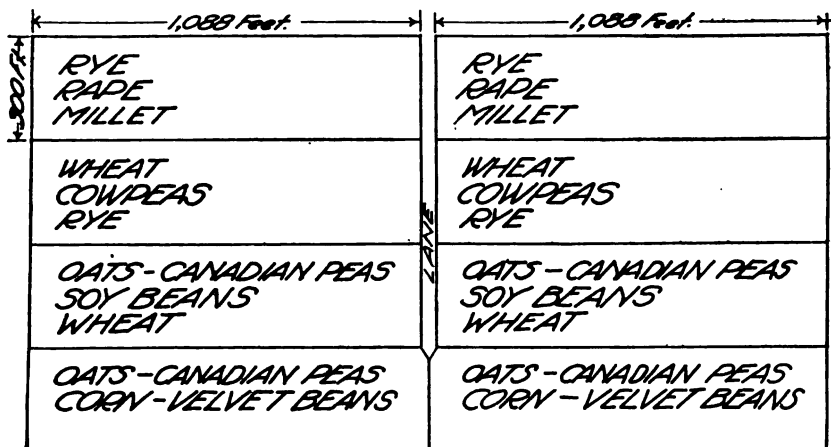


FIGURE 5.—Diagram of a farm showing a practical rotation of crops for each field for Central Atlantic and Corn Belt States.

Figure 5 shows a model farm plan for specialized sheep raising, and indicates a practical rotation of crops for each field for Central Atlantic and Corn Belt States.

⁵ See Figure 29, Farmers' Bulletin 810, Equipment for Farm Sheep Raising.

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FARMERS' BULLETIN 1182
UNITED STATES DEPARTMENT OF AGRICULTURE



FARM INVENTORIES



A NNUAL PROPERTY LISTS, or inventories, are of practical value to the farmer in many ways:

If progress is being made they accurately gauge the extent of it. If the farmer is falling behind, the lists will emphasize this fact. Often when a man is discouraged and thinks he is making no progress, his inventories will reveal to him the fact that he is better off than he thought, and thus give him courage. Such lists are the basis of any system of farm accounting that may be established.

The various uses of farm inventories are explained in this bulletin, which presents complete and explicit directions as to how to make, use, and care for a farm property book.

Contribution from the Office of Farm Management and Farm Economics.

H. C. TAYLOR, Chief.

Washington, D. C.,

December, 1920

FARM INVENTORIES.

J. S. BALL,
Junior Farm Economist.

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HOW MANY FARMERS know accurately their net financial worth, or how their investment in farm property is distributed? How many know, even approximately, how much they are progressing or falling behind each year? This information, which should be available to every farmer, as well as other facts of importance, can be obtained by preparing a list of farm property and farm debts every year.

Property lists, or inventories, as they are called, are not difficult to make, and are of great value to any farmer who is striving to better his condition, overcome obstacles to success, and place his business affairs on a secure foundation. To drift along, year after year, not knowing whether towards success or failure, is not the practice of business men. The farmer, as a business man, should know which way he is going.

Where farm records or accounts of any kind are kept, the inventory or property list is indispensable. It is the most valuable of all farm records, and is the starting point in any system of farm accounts. It helps to adjust the data set forth in other records, and without it reliable figures as to profits and losses can not be obtained from any records.

To gauge progress by increase in cash in hand, or to measure loss by additional debts incurred, without taking into consideration decreases or increases in the value of all property owned, is to invite false conclusions. The storekeeper is well aware of these facts, and his annual "stock taking" is nothing more or less than the making of an inventory or list of property, without which he is lacking accurate information concerning his profits and losses. A business man, lacking the facts as to the value of his property, year by year, can form no accurate estimates as to how he stands financially, no matter

what other records he may have. This is as true for the farmer as for any other business man. His increase in cash may be due to his having sold property which he had on hand from the year before. The increase in debts may be due to improvements made, or increased quantities of unsold crops and stock on hand, that make the actual net worth of his entire property greater than it was the year before.

Some farmers may know approximately the total value of their property, but it is doubtful if there are many whose eyes would not be opened by the facts set forth in a complete list. Even those who can make fairly accurate estimates of what they are worth can not make use of such estimates as they could of the full, complete, and accurate written schedules of the facts.

Before attempting to make and use an inventory it is well to have at least some knowledge of the principles involved. Unless the list is complete and made with sufficient care as to accuracy in placing values, it can not be of the greatest usefulness. Although no special kind of book or form is essential to success in the making of an inventory, yet a method is advisable that will expedite the making of the lists both at the start and in subsequent years.

This bulletin has been prepared to illustrate convenient inventory record books and methods of listing the property; to explain how to go about the work; what descriptive data it is advisable to record about the different kinds of property; how the items should be grouped in the list to allow for expansion in the number from year to year; what principles and points are to be kept in mind when appraising or placing values; how to sum up completely the years' lists; how to lessen the work of making subsequent lists; how to use the data, and how to care for the book.

HOW TO PREPARE A FARM INVENTORY BOOK.

The farm property book may be either bound in book form or carried in loose-leaf style. Both forms have their advantages and drawbacks and each one must decide for himself which kind best suits his needs. The bound book is more permanent in form and is cheaper in first cost, but it lacks complete flexibility, since a page in an account book of usual size allows only space enough for a few years' lists, and the entries have to be more or less cramped. The loose-leaf method overcomes most of the objections to the bound book, but the books are more expensive and lack the permanence of binding which is a good thing to have in a record which will become permanent.

A practical plan which overcomes some of the objections to both kinds of record book and saves considerable labor is to make use of the "long and short page" plan. This plan avoids entering name

and description of any item more than once for a number of years. Figure 1 shows how an ordinary blank book with "record" ruling, by hand ruling and cutting pages, can be made to serve as a farm property book for many years. Such a book can be purchased at any stationer's for a small sum. The book illustrated has 200 pages, each $7\frac{1}{2}$ by $12\frac{1}{2}$ inches, and costs from \$1 to \$2. By using the plan suggested it would do for 30 to 40 years' lists on most farms.

Figure 2 shows how loose sheets may be prepared and bound for use as a property book. While the ruling and printing of these sheets would be more expensive than the cost of the bound book shown in

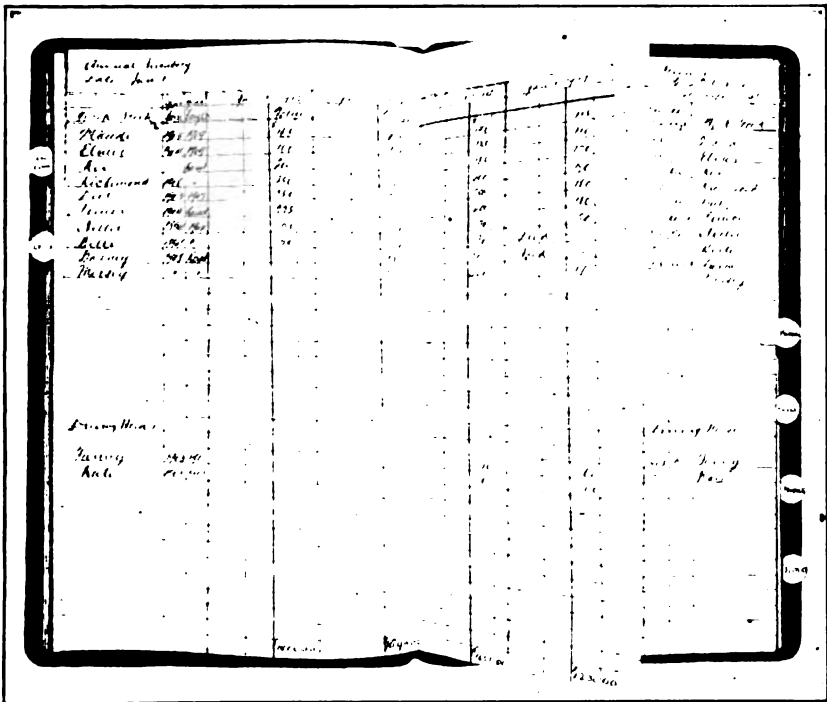


FIG. 1.—An ordinary blank record book, ruled for listing farm property. By trimming intermediate leaves, recopying is avoided for many years.

figure 1, the printed loose-leaf feature obviates all hand ruling, prevents congestion or cramping of the data, and preserves perfectly the continuity of the record. Each item is listed but once and the extra short sheets for subsequent years are inserted as needed. As in the bound book, the ends of all the sheets but that containing the items and descriptive data are cut back and by this means recopying is avoided. To the uninitiated it may seem that the book illustrated in figure 2 is rather reversed from the way most people are used to handle accounts, because the descriptive matter is at the right-hand side of the page. This is much better

than having the book open from left to right, thus having the roll of the sheets under the right arm and wrist and in the way when making entries. The plan illustrated is best for a right-handed person. The sheets shown in figure 2 are 12 by 20 inches in size, and each takes care of the items of property listed thereon for six years' inventories. Ample space is allowed for the entries on sheets of this size. The original sheet and four short continuation sheets will be sufficient for the items listed on the original for 30 years' inventories. These loose sheets can be held in any suitable binder with the descriptive matter and binding at either end. The homemade "folder" illustrated in figure 3 is durable and adequate.

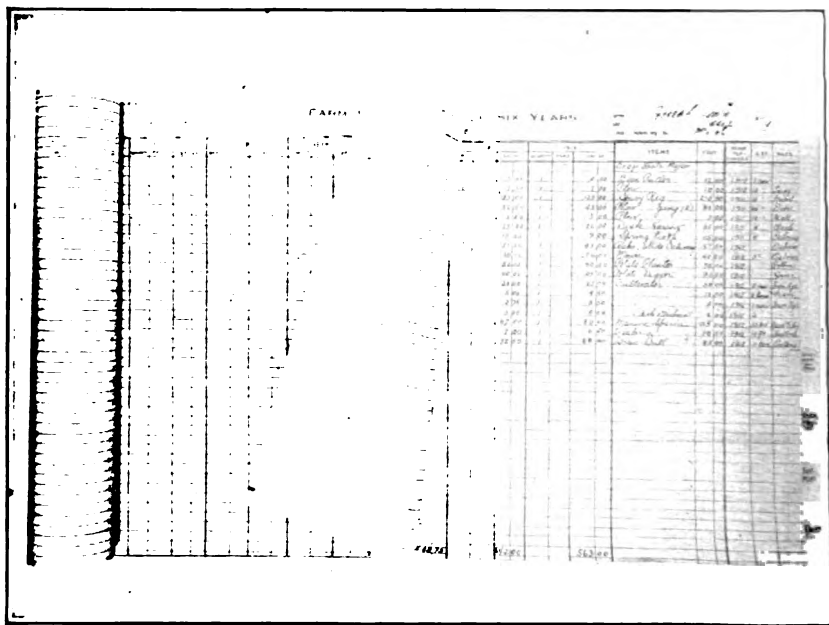


FIG. 2.—Inside of loose-leaf property book, showing use of trimmed sheet to avoid recopying.

It is made by a stiff pasteboard back, a little larger all around than the sheets, which, with the cover, are bound to the back by two paper fasteners of the cotter-pin type, through a strip of pasteboard on top of the sheets. A study of figure 3 will show exactly how this is done.

INDEXING.

To make reference easy to any sheet in the inventory, it will be found convenient to attach index tabs to the margin of the pages, as shown in figures 1, 2, and 3. These index tabs can be made of any suitable material. Those illustrated are made of paper, are conveniently gummed and ready to attach, and can be purchased cheaply at any stationer's.

BEST TIME TO MAKE AN INVENTORY.

There is no date in the calendar that is the one best time to make an inventory for everybody and under all circumstances. Each one must decide for himself the date most convenient. In deciding on a date the most important consideration is to select a time of the year before the season's work in the field begins. It will save trouble in the estimating of the quantities of farm produce on hand if the date is made as late in the spring as possible before field work begins, and when the supply of produce left over is low.

Although any day will do, it is best to select the first day of some month, and a fairly good guide in any section will be the date upon

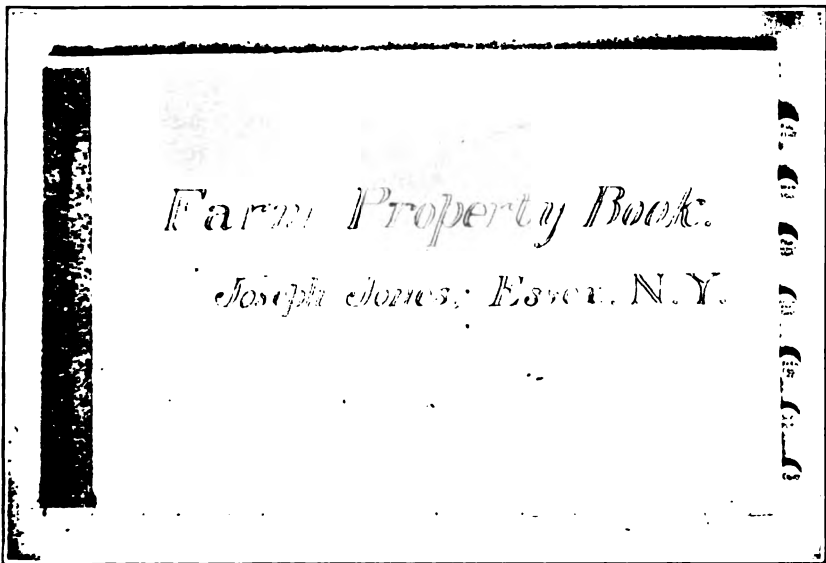


FIG. 3.—A homemade inventory book, containing sheets illustrated in figure 2.

which tenants customarily change farms. The best inventory date may vary all the way from January 1, in the Cotton Belt, to April 1, in New England, and for special farms special dates are often required.

HOW TO LIST PROPERTY.

If no list of the farm property has ever been made, it is well to start operations by going over the farm, field by field, and building by building, taking each item as it is found. Thus nothing will be missed. The listing can be done in any memorandum book or on loose sheets of paper. Two people can do this with greater facility than one, especially in barns, tool houses, and like places where many articles are found. One person can search out the various pieces of property, calling out each item in turn, to be set down on the list

by the other. The classifying and appraising can be done at the same time, if desired, by listing the items coming under each class of property on separate pages or sheets, but for the most part classification and appraisal can best be done within doors as the items are being copied into the property book. In some cases a more exact appraisal may perhaps be made as the item is listed, but it is not necessary for the average man to have each item of his property in actual sight in order to give it careful appraisal. It is necessary, however, to have the items actually in sight when they are being listed, as otherwise some of them surely will be omitted. Descriptive information regarding each item should be set down as the listing is being done, for identification purposes, as hereafter explained.

COPYING TO PROPERTY BOOK.

The copying of the listed items to the property book and classifying them at the same time can be most easily done by having one person read off the items as listed and another turn the pages of the book and enter the data under proper classified headings. This work should be done carefully, and at the end of each group plenty of room should be left for listing any new items of the same class that may be acquired in the years to come. In the following pages will be found fully detailed suggestions as to the best way to classify or group the many items, also how to apportion the items to the pages of the property book. Appendix A sets forth a fully detailed inventory from a New York farm, which merits careful study.

DESCRIPTIVE DATA.

It will be noticed that there are three narrow columns on the forms shown in figures 1 and 2, next to the wide column provided for listing the items. These three columns are to be used to note certain descriptive data concerning certain classes of property.

The descriptive data will depend on the kind of property. For the land, the year of purchase and the first cost should be recorded. Each building or improvement should be accompanied by notes as to the year erected and the first cost. For the work animals and any other stock listed by name, the data should show the year born or bought, and the first cost, if bought. For each implement listed separately there should be a record of the year bought, the first cost, and the size or working width. The make of the implement may also be set down. Such data will prove of value should the inventories be used in an accounting way, and in any case will be well worth the recording, as in going back over the lists of previous years descriptive data will be found quite useful in fully identifying many of the items.

CLASSIFYING AND APPRAISING THE PROPERTY ITEMS.

The various items in the list of farm property must be classified into groups. This is necessary for convenience, ease of reference, subsequent identification of items, and to secure the figures as to capital invested in each kind of farm property.

The allotment of pages in the inventory book to each group or kind of property must be made carefully in order that there may be no great waste of space, and yet ample room allowed for listing additional similar items acquired in the years to come. The various classes of property will need space in the book in accordance with their differing characteristics.

The appraising, or placing of values on all the items that go to make up the farm property list, will require careful thought and consistent action. Diverse conditions and principles are involved in the appraisal of different kinds of property, and these will therefore be discussed at some length.

RESOURCES OR ASSETS.

All property *owned* comes under the head of resources or assets. The resources may be divided into two subdivisions known as *physical* or tangible property and *financial* or intangible property. These are the technical terms used in everyday business, and their meaning should be fully grasped, as they refer to entirely distinct kinds of property, the handling of which in an inventory is governed by entirely different principles. The value of the physical property must be estimated and appraised; the financial property has a *face value*, which under any conditions ordinarily met with on the farm needs no appraisal. The physical property may be grouped under the following heads: Land; buildings; other permanent improvements; work stock; cattle; swine; sheep; poultry; machinery and tools; farm produce; farm supplies; growing crops. The financial items include cash on hand, cash in bank, accounts receivable, and notes receivable. By "receivable" is meant debts owing to the farm. All these classes of property will now be taken up in turn.

LAND.

It is not necessary to discuss in this bulletin in any but the briefest and most casual manner the theoretical methods of correct land valuation. The main thing is to adhere to whatever principle is adopted, so as to eliminate all fluctuations due to variations in method or basis used. The objects of valuation of the physical property (including land) for farm inventory purposes are, generally speaking, threefold; (1) to establish a basis for determining financial worth at recurrent periods, thus reflecting increases or decreases in net worth;

(2) to ascertain the distribution of capital invested; that is, the amount of money tied up in each class of property; (3) to serve as a basis in farm cost accounts for charging depreciation and interest on investment. By bearing in mind the foregoing, the necessity is readily seen for sticking to some definite method of valuation. In the valuation of land there are at least three bases that may be considered: (1) Cost; (2) sale or market value; (3) capitalized rent. The difficulty with the cost basis in appraising farm lands is that it fails to fulfill completely any one of the three objects of valuation as hereinbefore specified. However proper the cost basis is in corporation accounting, where it is generally accepted and used, it fails when applied to farm land valuation. This is partly because of the personal element present in farm accounting and absent in corporation accounting. If the land value be based on cost it will certainly not reflect the farmer's present net worth. In many cases land cost its present owners a nominal sum only. Again, many farms have been inherited, thus costing their present owners nothing. For these reasons, generally speaking, the cost basis is not acceptable in land valuations for farm inventory purposes. Where the land has recently been purchased, however, cost is the best appraisal basis.

The sale or market-value basis will doubtless prove the most practical in the majority of cases, but certain precautions are necessary in applying it. If this method is adopted the land should be appraised as nearly as possible at a figure representative of the current price in the neighborhood of the same kind and quality of land. By current price is not meant a forced sale price, nor yet a fancy suburban lot valuation, but such a price as the more recent sales to farmers have shown to be the real market value of land in the locality. Almost every farm will include areas of different value per acre. These should be separately priced in accordance with their values, and, to facilitate future appraisals, each field or parcel of land may be designated by a letter or number for purposes of identification. The number of acres in each kind of land, multiplied by its appraised value per acre, will give, when footed up, the total appraised value of the land. (See sample inventory, Appendix A.)

It is sometimes rather difficult to judge of the actual market value of farm land. Especially is this true in regions where there is great activity in the land market, and also in those sections of the country where there is little or no buying and selling of farm lands. In the former case the element of speculation and in the latter the scarcity of sales prevents the taking of sales prices as a guide.

The third basis, capitalized rent, is probably the best index of the intrinsic value of land. Dr. H. C. Taylor¹ in his recent work on

¹ *Agricultural Economics*, 1919, pp. 204-205.

Agricultural Economics says: "The net rent, or the share of the gross returns which, under conditions of free competition, is credited to land, above what is necessary to keep the land intact, is the starting point for figuring the value of a piece of land." He further says that this net rent divided by the rate of discount which "reflects the prevailing premium on the present" is the simple mathematical method of finding the value of a piece of land on this basis. Thus, "If the net annual income derived from a piece of land is \$6 per acre and the rate of discount is 5 per cent, the present capital value of the land would be \$120 per acre," or \$6 divided by 0.05.

Where this method can be applied it is probably the most accurate one that can be used from an economic standpoint. Its main difficulty from the standpoint of farm inventorying is its application where the land is being farmed by its owner. The earnings are produced by the entire farm property, land, buildings, stock, equipment together with the labor employed, and the difficulty lies in allocating to each of these factors of production its true share of the earnings. For instance, a field produces certain net earnings above all costs. By what means in reach of the practical farmer is the share of earnings attributable to each factor to be set apart? Another practical difficulty lies in the fact that crops are not uniformly productive, neither are seasons, and the net rent would be more variable and inconstant, both up and down, than the market value basis, which usually follows a general trend, either upwards or downwards.

Thus while it is undoubtedly true that the net rent over a period of years is an excellent if not the best index of its actual value, there are practical difficulties of application that render its use for this farm inventory purpose unavailable in the majority of cases.

In appraising the farm land, especially if cost accounts are to be carried, it is desirable that each kind of land (as crop land, permanent pasture, woodland, etc.) be valued as nearly as possible at its relative value as compared with the other kinds. In some cases it has been found expedient to go still further and assign to each separate piece of land on the farm its own value per acre. (See Appendix A.) The value per acre of each kind of land multiplied by its area will thus give the total land value as appraised by this method.

This method is a good one to follow, for on practically all farms there are found areas of different value per acre. Thus some tillable land may be high in fertility and easily worked, being for this reason worth considerably more per acre than other tillable land of lower fertility or less desirable physical characteristics. Again, many farms include areas unfit for tillage by reason of swampy, rocky, or very hilly topography. Woodland and brushy areas are found in

nearly all agricultural regions. In some cases the woodland is worth more, in others less, than the best tillable land, depending on the section of the country and the quality of the timber. To appraise all these at a uniform rate per acre would not be in accordance with the facts, and it is the facts that are desired when making an inventory.

ORCHARDS AND OTHER PERENNIAL CROPS.

The appraisal of orchards and similar semipermanent crops, such as asparagus beds, berry plantations, etc., is best made as one with the land they occupy. They are, strictly speaking, a part of the make-up of the land value, for, if the land be sold, they are legally a part of the sale and go with the land. In appraising land carrying such crops the value should not be overestimated on the basis of expected returns, however certain it may appear they will be. Conservatism should here, as elsewhere, be the rule. The same basis as for any other land may be used or, if the costs of bringing such a crop to bearing age are known, they may be used in this connection by adding to the value of the bare land the costs, year by year, to bring the crop to full bearing age. The full value should be maintained during the prime productive life, and then, as productivity wanes, the value should be gradually decreased until, when the fruitfulness of the crop ceases, it is again reduced to the value of the bare land.

BUILDING AND OTHER IMPROVEMENTS.

Each building or improvement (water supply, lighting system, etc.), should be listed separately. (See sample inventory, Appendix A). It is best not to list separately other land improvements, such as fences, drainage, and the like, but their value should be included in the appraisement of the land so improved.

One of the most perplexing appraisals will be that of the farm buildings and other improvements. The buildings and improvements are bought and sold with the land, and it may often appear difficult to give them a value separate from the land. This is not so difficult as it may seem, and it is of importance that they be separately valued, as only by this means can all the uses of the inventory be realized. Furthermore, this is necessary in order that new building improvement costs be correctly inventoried and depreciation be adequately provided for.

There are two bases which may be employed in appraising buildings and improvements, (1) original cost of construction, and (2) estimated cost to replace at present prices. In either case allowance should be made for depreciation from the date of erection to the inventory date.

To illustrate, assume a barn to have been erected in 1880 which cost then \$800, but to-day would require \$2,000 to build. The barn is in good repair and has an estimated life of 20 years longer before it will have to be replaced. On the original cost basis the barn would be valued to-day (1920) at \$267, while if the replacement basis is used the present value would be \$667, or one-third of the total in each case, as it is estimated that it has one-third of its useful life left. The question of the salvage value at the end of useful life sometimes enters into such computations, but this question is ordinarily ignored in farm inventoring for the reasons that it is usually a negligible amount, and that the actual useful life remaining is largely a matter of guesswork. There are usually no extensive, accurate data on which such estimates can be carefully based.

The original cost basis is, doubtless, the safest and most conservative for general use in valuing buildings, but in many cases and for some reasons the replacement basis may be found preferable. Thus, if cost accounts are to be carried on, the replacement basis seems to be more justifiable in order that the cost figures may bear depreciation charges commensurate with the present high scale of prices. All building materials have advanced so greatly in cost in the last few years that the original cost of any building, except one very recently erected, can not be considered an accurate guide to its true value.

Under no circumstances, however, should the basis of values be shifted from year to year, but, when once decided on and established, should be maintained until price levels have materially changed.

When estimating depreciation, careful examination is to be recommended. Sometimes a building apparently in perfect condition has been found to be quite out of repair by reason of unseen depreciation due to rotted sills, posts, etc.

When the appraised values of the various kinds of land, of the several buildings, and of the other improvements are footed up, it will nearly always occur that the total appraised valuation by the sundry items will not agree with the cost or appraised value of the farm as a whole. It would be manifestly inaccurate in such a case to leave the total itemized value as it is, and yet it is desired to have the data in itemized form. Here it becomes necessary to divide up the "whole farm" value into proportionate values for each item, as indicated by the detailed appraisal. This is more readily done by placing the items in a column with the total appraised value at its foot. Alongside of this column is another for holding the adjusted values and at the foot of this second column is placed the "whole farm" value to which it is desired to adjust the item values. The ratio of values or the adjustment percentage can be found by dividing the total "whole farm" value by the sum of the itemized values.

This percentage figure, multiplied by each item in the appraised values, adjusts each itemized value to the total value. To illustrate:

Items.	Appraised item values.	Adjusted values.
Fields A and F, tillable land, 80 acres.....	\$8,000	\$7,361
Field C, tillable land (poor), 20 acres.....	1,000	920
Fields B and E, permanent pasture, 20 acres.....	800	736
Farmstead, woods, roads, and lanes, 5 acres.....	300	276
Dwelling.....	1,500	1,381
Tenant house.....	400	368
Barn.....	850	782
Calf shed.....	50	46
Corrrib.....	75	69
Henhouse.....	10	9
Water-supply system.....	350	322
Lighting system.....	250	230
Total appraised value by items.....	13,585	12,500
Total "whole farm" value.....		

In the above case the "whole farm" value is found to be 92/100 of the total of appraised item values (12,500 divided by 13,585). The figures for each item in the column of adjusted values are found by multiplying each item value by 92 and dividing by 100.

One page in the farm property book ordinarily suffices for the list of land, buildings, and improvements.

LIVE STOCK.

Live stock on the farm ordinarily comes under three heads, namely, work stock, production herds and flocks, and special lots such as steers, hogs, or lambs bought for fattening and resale. In each case, as for the farm land, there is the alternative of using the cost basis or the market value basis for the appraising of values. As recommended in that case, so here, considering all the objects for which a farm inventory is used or to be used, the market value basis is the most acceptable. It must be understood that market value *at the farm*, or "farm value," as it is commonly called, is meant in this connection. That is value at market point *less* probable cost of getting to market. In no case should live stock be valued at full value at the market point.

Work stock.—The appraisal of the work stock should not give much trouble. Most farmers know pretty well what a horse or mule is worth after owning it a while. It is well to devote one page to the work and driving animals and colts, which by reason of being a more or less permanent part of the farm plant should be listed separately by name. As colts raised are broken and put to work on the farm, they can be dropped from the list of colts and carried to the work stock list. Several blank lines should follow the list of each.

Productive live stock.²—This list will include:

Cattle: List each kind of cattle separately, as cows, heifers, bulls, steers, calves, yearlings, and 2-year-olds.

Colts: List as suckling colts, yearlings, 2-year-olds, etc.

Hogs: List separately breeding sows, boars, feeders, shoats, pigs.

Sheep: List separately ewes, rams, wethers, and lambs.

Poultry: List separately hens, roosters, chicks, turkeys, ducks, geese, and guineas.

Bees.

If more than one breed or type of animal is kept it may be advisable to separate the above groups under the different types or breeds, as "dairy cows," "beef breeding cows," "Holstein calves," "Shorthorn calves," etc. Where dairy or registered breeding stock is carried it is advisable to list all the cows, bulls, and young stock individually by name, as is done with work stock, so as to facilitate identification and appraisal year after year.

Special lots.—There is a radical difference between the principle of listing semipermanent stock and that of listing hogs, steers, and the like, which are kept only a relatively short time. It is necessary to leave considerable blank spaces on the sheets listing individual animals, for as they are sold or otherwise disposed of the others that take their places will need to be listed on the same sheet in order to preserve the continuity of the inventory. The list of stock bunched according to kind and age will, however, stand indefinitely, since the individual animals that make up these bunches may come and go without requiring any change in the listing. Such a list should simply show after each group the number on hand and the total value of the entire bunch. The important thing to be remembered here is that a few blank lines should be left after each distinct class, such as cattle, swine, poultry, etc., to allow for occasional changes that may occur in the make-up of the live stock carried.

A method of valuation practiced on stock farms is to weigh the different bunches, multiply the total weight of each by the current market price, and subtract the probable marketing charges. The remainder shows the market value on the farm.

The number of pages in the property book to be allotted to productive live-stock lists will depend greatly on the size and type of farm and the kind of stock carried. Generally a page will suffice for all the bunched animals. Where some of the cattle are individually listed it would be well to use one page for the bunched animals and one or more pages as needed for the individually listed cattle.

² By this term is meant all classes of stock which are maintained for the production of income either through sales of stock and stock products or by increases in value.

MACHINERY AND TOOLS.

The appraisal of the farm implements presents quite a different problem from that of any other class of property on the farm. Market prices are of little use here in determining actual values. A farm implement after only a few months' use has a cash sale value considerably less than what it is actually worth to the farm. There is one rule for appraising these values that has been found to work out well in practice, namely, from the first cost deduct a sum sufficient to cover wear and tear up to the inventory date. To do this, the probable useful life of the implement must be considered. For instance, in appraising the value of a plow, the first cost of which was \$12, and which has been used for 12 years and has about 3 years more of useful life, the value would be placed at $\frac{3}{15}$, or $\frac{1}{5}$ of the first cost, that is to say \$2.40. In arriving at first cost, the price paid and the cost of getting the implement to the farm and setting it up are to be added, thus making the total first cost.

This is the most numerous class of property items to list. The best way is to treat every separate implement, machine, or tool as a distinct item on the inventory. In the case of such minor tools as shovels, hammers, axes, and the like, where more than one of the same kind is owned, they can be listed together, followed by the number owned, as "hammers, claw, 3"; "shovels, long-handled, 2," etc. All major implements should consistently be itemized separately to identify them for future lists, as, "Mower, Deering 4½-foot cut," "Mower, McCormick 5-foot cut," etc.

It may seem to many that the listing of each separate tool is an unnecessary burden of detail, but there are at least three good reasons why this should be done. First, the values can thus be more accurately placed; second, the list is made but once for each tool and future appraisals are more easily consummated; third, the loan, loss, or misplacement of tools is readily brought to mind and checked up. Farmers frequently lose valuable implements by lending them out and never checking up their lists of property. A case of a farmer in New York illustrates this pointedly. He used to lend his fanning mill to his neighbors and on one occasion when he wanted to clean his own grain, it was not to be found, either on his own place or at any of the neighbors. It finally developed that it had been sold by auction at a sale of the effects of a deceased neighbor. No one remembered who had bought it, hence it was a total loss. Similar losses are avoided by farmers who have formed the habit of making annual inventories. On many farms both the number and value of small tools are maintained about the same year by year, the new small tools bought each year representing a year's depreciation, so that on these farms the listing and appraisal of small tools may be

done by groups without making much difference. It is recommended, however, that in spite of the time required an exact itemized list be made of each tool, large or small. The grouping idea is suggested merely to show how the listing may be done when circumstances seem to make an itemized list undesirable, as may sometimes be the case on quite small farms or on those where a simple type of agriculture is followed.

Making this list of the tools will appear to many a much more tedious job than it actually is. On a 320-acre general grain and stock farm in Iowa, where seed growing and cleaning is made a specialty and a thrashing outfit handled, a farm where about every implement and tool is represented that will be found on any farm, the detailed list showed 301 separate items, from a \$1,100 thrashing outfit to a 5-cent file. In spite of this extraordinarily long list, the inventorying was not exceptionally laborious, consuming less than one day's time, and after the list was once made the succeeding year's lists were checked up with facility.

It will systematize the work if in copying this list to the apportioning pages in the farm property book subclassifications be made in accordance with the uses of the tools, entering first under each class the major items, and then, after leaving a number of blank lines, the minor tools. As a suggestion, the groupings illustrated in the sample inventory in Appendix A are offered.

These groups on a farm of average size should prove adequate, but where there are a great many items it will be useful to have the list still further subdivided. For instance, the live-stock tools may be classified by kind of stock, the crop implements by the different kinds of crops, and the general-purpose tools into "hauling," "shop," and such like groups. Where this is done certain items will be found that can not go under any one subgroup and must be included in a general-purpose subdivision at the end of each series of subdivisions.

The allotment of pages in the property book to the lists of machinery and tools will depend on how the items are grouped. On small farms, one or two pages may suffice for the entire list. Where the tools are classified into groups, each group should have a separate page, to allow for subsequent purchases, and where a great many items are to be listed, separate pages are advisable for the major and minor subclassifications under the same group.

FARM PRODUCE.

For farm produce the best appraisal basis is believed to be "farm value," or market value at the farm, that is, at market price less the estimated cost of marketing. Each product on hand at inventory

time should be listed, followed by a note as to kind and quantity on hand, and the unit of measurement, thus:

Corn, ear.....	bushels..	432
Hay, timothy.....	tons..	4½
Hay, mixed.....	do..	16

The task of making fairly accurate estimates of the quantities in bulk of such commodities as corn, wheat, hay, etc., may puzzle some who have never made such estimates. There are rules for closely approximating these, and in many instances farmers have their own methods by which they make surprisingly close estimates. For the benefit of those inexperienced in such estimates, Appendix B gives simple rules for estimating quantities of produce in bulk.

SUPPLIES.

On every farm at inventory time there will be found a miscellaneous collection of all kinds of supplies, such as purchased feeds, seed, fertilizer, twine, nails, lumber, etc. These, together with the amount of manure on hand, are all listed under the heading "Supplies." Nails, bolts, screws, and the like can well be listed as one item, regardless of varying sizes and kinds, giving the approximate number of pounds. Where a definite system of carrying such shop supplies is in use, as is the case on some of the well-organized, large farms, the quantities of the different items of this nature are easily counted or weighed and appraised with exactitude. This kind of property, like machinery and tools, has been bought by the farmer and should therefore be appraised at cost price *plus* any expense incurred in getting it to the farm. For example, if a ton of bran is bought for \$44, \$1.25 spent for freight on it, and 75 cents worth of man and horse labor needed to haul it from the station to the farm, the appraisal should be made at the rate of \$46 per ton.

FALL AND WINTER CROP WORK.

This is an important part of the farm inventory, and one that is sometimes overlooked. Strictly speaking, it is not property in some parts of the country, but in other sections it is just as much property as a horse or cow. In most States, in the sale of tenant farms, the law requires that the tenant must be compensated for his work on any crops not yet harvested, even when no written lease is extant.

From an accounting standpoint it is indispensable that the value of the work done and supplies used on crops to be harvested in the coming season be taken into account. If a farmer sows each year about the same number of acres of winter wheat and other like crops, if he winter-plows similar areas year after year, in other words, if the inventories of the value of such expenditures of labor and money will amount to practically the same thing each year,

it may be allowable to omit them. But it is little trouble to include them, and even under such exceptional, unvarying conditions it is best to do so. The physical facts of such data, as number of acres plowed, or planted in each fall-sown crop (including quantities of seed, fertilizer, etc., used), will be of use for reference and are worth recording, even though the money values are not considered necessary to the accounts.

The items that go to make up the value of the fall and winter work on crops to be harvested in the coming year are labor (man, beast, and tractor), seed, fertilizer, and other supplies used thereon. In the absence of labor records on the farm, the labor cost of this item will have to be estimated, but as most farmers have a pretty fair idea of the time it takes to plow an acre of land or put in an acre of fall grain, this should not give much trouble.

On small and medium-sized farms the farm produce, supplies, and crop work may be listed on one page of the size shown in figures 1 and 2, and still leave room for future years. Where the items are numerous, separate pages should be used for each group. Dairy farms, especially those on which various feeding systems and rations are being tried out, may require an entire page for the concentrate feeds alone, as the list will vary from year to year.

GENERAL NOTES ON APPRAISING.

Good judgment, coupled with experience, should enable a farmer to come fairly close to the right figures. A middle course is the safest, since the results of an appraisal either far too high or far too low will be of little or no value. False appraisal, to make the figures show up well, is labor thrown away, since the one who indulges in this pastime is only fooling himself. Stick to facts. Use market values (except as explained for machinery and tools) *adding* expense of getting to the farm all those things the farmer buys, and *subtracting* the probable expense of marketing from the market value of all those things he has to sell.

FINANCIAL PROPERTY.

The foregoing discussion has covered all the property which is classed as physical, or tangible, and which needs to be appraised as to values. The property now to be considered is that which may be classed as intangible, or financial property, and consists of the amount of cash on hand and in bank, open accounts receivable, or amounts due the farm from other people or firms, and notes which the farmer holds on the inventory date. A farmer often owns other property such as stocks, bonds, life insurance policies, and other resources of the sort, but these do not pertain to the farm and do not

belong in a list of farm property. They may, however, be included if it is thought desirable to do so.

One page of the farm property book should be devoted to this list of financial property, listing the notes, open accounts, and cash, in regular order. It is well to leave some blank lines after both the list of notes and accounts, and to carry the cash on hand and in bank on the lower lines of the pages. In listing the notes and accounts some descriptive words should be added showing who owes the money, for what, when due, etc., as shown in the sample inventory in Appendix A.

LIABILITIES.

In no case should a list of liabilities (bills and accounts *owed by* the farm) be omitted from the inventory. Liabilities are an offset to the resources. They are a part of the make-up of the farm business and the proportion they bear to the resources indicates the degree of thriftiness of any business. A separate page in the property book should be devoted to the liabilities, and the items should be entered just as indicated for notes and accounts owing to the farm, giving the name of the person or firm to whom money is owed, whether note or open account, when due, for what the debt is owing, and the amount.

SUMMING UP.

When all the items with their valuations have been entered in the farm property book, all that is necessary to finish the job is to sum up the values. This is best done by adding each page separately and carrying these page totals to the last page of the list, where they may be conveniently added to obtain the grand total. It is not a good plan to carry forward each total to the top of the succeeding page. The totals become more and more cumbersome to handle, chances of error are multiplied, and in case extra sheets are at any time inserted, confusion may result. The liabilities are summed up in the same manner as the assets. (See Appendix A.)

NET WORTH.

When the sum of the liabilities is subtracted from that of the resources, the remainder is known as the net or present worth. By this is meant the net value to the owner of the farm property after all debts are accounted for, or, in other words, the net amount of capital invested in the farm business at the inventory date.

SUBSEQUENT ANNUAL LISTS.

Having made a fully detailed inventory for one year, the task of making subsequent annual lists is comparatively easy. There are certain particulars to be considered in the making of these subsequent lists which will now be explained and briefly discussed.

LAND.

Unless land has been bought or sold, the total acreage will remain unchanged. Clearing of woods or brushy areas and reclamation of wet lands may change the areas listed at different values, and therefore the total value. Any amounts expended in such improvements should ordinarily be added to the old to make the new values, but the value per acre should never be increased by such additions to a greater amount than the current price for such improved land. Increased or decreased value by reason of a general rise or decline in the price of land in the locality wherein the farm is located should be taken into account, but where the inventories are utilized as part of an accounting system, this increased or decreased value should not be included in the farm profits or losses, but should be shown separately as an unearned gain or loss.

BUILDINGS, WORK STOCK, MACHINERY AND TOOLS.

These three classes of property, with the land, make up what may be termed the farm plant. Just as a factory with its buildings, machinery, and rolling stock is spoken of as a manufacturing plant, so may that permanent part of the farm property used over and over again in the production of crops and stock be considered a manufacturing plant, and, similarly, these are subject to losses every year by weather, becoming out of date, wear and tear, and other causes. This decrease in value must be taken into account in appraising farm property if an approximation to actual values is to be regularly maintained. As a general principle it may be said that all parts of the farm plant decrease in value year by year unless this decrease is offset by maintenance.

The land value will not ordinarily depreciate if the fertility of the soil is adequately maintained. Buildings properly erected depreciate in value very slowly, so gradually, in fact, that if kept in thorough repair their value will be maintained indefinitely. Where repairs of a permanent nature, such as a new roof, are made the inventory value may be necessarily increased. A rule for appraising well-built frame buildings which has given satisfactory results in practice is to deduct from the previous year's value 3 per cent on the cost of erection (or on estimated replacement cost if this basis is used), and to the remainder thus found add the cost of maintenance during the year just past.

The values of the machinery and tools may be appraised by deducting from the valuation of the previous year an amount expressed in terms of a given per cent on the first cost. The percentages to be deducted will, of course, vary for the different implements. The probable useful life of each implement will be the governing factor here, as explained in Appendix, C.

The decrease in value of the work animals, year by year, will be fully accounted for if their values are carefully appraised each year. Some of the younger animals, no doubt, will show an increase in value, as would naturally be the case up to a certain age.

PRODUCTIVE STOCK, FARM PRODUCE, SUPPLIES, FALL AND WINTER CROP WORK.

For the subsequent annual listing and appraisal of these classes of property, the method of procedure will be the same as in the original inventory.

CASH, NOTES AND ACCOUNTS RECEIVABLE, LIABILITIES, SUMMING UP, NET WORTH.

These are also handled in the subsequent inventories exactly as in the first instance.

ADDED ITEMS.

In making the subsequent lists there will be some additional items each year which have been acquired during the time since the preceding inventory was made. If a record of receipts and expenditures is kept, it is well to go over it just prior to the date of the inventory and make a list of all new items of property that have been acquired by purchase during the year which should go into the new inventory. By this means is avoided the chance of missing any of these new items. If no such record is kept, memory must serve instead.

USEFULNESS OF THE FARM PROPERTY BOOK.

Aside from the value of the data contained in a well-kept inventory in supplying complete information as to the value of the farm and its accessories, the distribution of the capital invested in the farm, and the net financial status of the farmer year by year, the data will prove useful in a variety of ways, in any one of which it will often repay the farmer for the time and work devoted to making the inventories. Some of these uses will be suggested.

AS AN INDEX OF PROGRESS OR RETROGRESSION.

A comparison of the net worth balances year by year will show whether financial progress is being made. Where this use is to be made of the figures it is usually necessary to make certain adjustments of the sums indicated by the inventories. For instance, if an outside investment, as stock in a creamery or other company, has been made from funds produced by the farm during the year, the amount so invested, not being included in the list of farm property, should, in measuring financial progress, be added to the figure representing the net worth at the end of the year. If an outside investment, as stocks or bonds owned, has returned dividends or has been

closed out and the money so received has gone into the farm business, this amount should be subtracted from the net worth to show just what gain or loss has occurred in the farm property during the year. To illustrate:

Net worth at the beginning of the year.....	\$22, 536. 92
Net worth at the end of the year.....	22, 390. 25
Decrease in net worth.....	146. 67
Outside investments made (bought stock).....	500. 00
Decrease in net worth (deduct).....	146. 67
Actual financial progress made.....	353. 33

AS AN AID TO FARM ACCOUNTING.

Such figures as the foregoing are valuable as indicating the financial progress of the farmer as an individual, but in no case do they indicate the profit or loss made by farming. To get at this last figure it is necessary to know how much was spent for household and personal expenses, what the farm furnished to the family living, and to what extent the value of work done by the farmer and his family saved expenses to the farm. To illustrate, if the value of the house rent, milk, butter, eggs, meat, vegetables, fruit, etc., furnished the farm family by the farm is found to be \$420, the amount of cash expended for the household and personal expenses of the farmer and his family \$740, and the value of unpaid farm labor of the farmer and his family \$485, the profit by farming would be found thus:

Financial progress made.....	\$353. 33
Value of supplies furnished (add).....	420. 00
Household and personal expense (add).....	742. 00
Total.....	1, 515. 33
Less value of unpaid farm labor.....	485. 00
Profit by farming.....	1, 030. 33

Of course, in order to obtain the figures represented above, the records indicated must be kept, in addition to the farm property lists.

The foregoing is the simplest way known to get at the actual profit made or loss sustained by the farming operations. Of course if more detailed records are kept, or a system of cost accounts handled, the inventory figures are indispensable, and accordingly the value of the property lists is still greater.

AS A CREDIT SAFEGUARD.

When a fully detailed list of property is available the borrowing of money for farm purposes is made easier and less costly. In a case well known to the writer, the farmer takes every inventory to

his banker and together they go over it. By this means complete confidence is established, and this farmer, in a section where interest rates charged farmers actually amount to 8 per cent or more per annum, has had no difficulty in securing what money he needs to carry out his farm projects at a straight 6 per cent per annum, enabling him to pay cash for everything he buys and save money all along the line.

ADJUSTMENT OF FIRE LOSSES.

In case of fire or other losses covered by insurance the inventory becomes invaluable as an aid to quick and satisfactory adjustment of the losses sustained. In case of a general fire it becomes of incalculable value in this respect.

CARE OF THE BOOK.

Such a valuable asset as the farm inventory book should be the object of particular care. It always should be kept in a safe place where it can easily be saved in case of fire. It should be kept away from promiscuous handling or prying eyes, and should never be exhibited to anyone except in the necessary course of business, or to give accurate information to properly accredited representatives of the State and Federal Governments. Whenever it is so used, it should always be with the understanding that the information so furnished is to be held strictly confidential.

APPENDIX.

A. SAMPLE OF A COMPLETE FARM INVENTORY ON A 125-ACRE FARM IN WESTERN NEW YORK.

INVENTORY OF FARM PROPERTY ON THE PINE TREE FARM, MAR. 1, 1920.

Page of prop- erty book.	Property.	Quantity.	Price.	Value.
1	Land:			
	Field. A. Tillable.....acres..	19.3	\$96.00	\$1,852.80
	B. Tillable.....do.....	19.4	96.00	1,862.40
	C. Young orchard.....do.....	4.9	150.00	735.00
	E. Tillable.....do.....	6.7	96.00	643.20
	F. Tillable.....do.....	4.57	96.00	438.72
	G. Tillable.....do.....	5.0	96.00	480.00
	H. Woodland.....do.....	22.6	40.00	904.00
	I. Bearing orchard.....do.....	3.83	300.00	1,149.00
	J. Tillable.....do.....	6.2	96.00	595.20
	K. Tillable.....do.....	15.7	96.00	1,507.20
	L. Tillable.....do.....	10.0	96.00	960.00
	N. Quince orchard.....do.....	.5	96.00	48.00
	Garden.....do.....	.35	96.00	33.60
	Roads, waste, etc. (no value placed).....	6.14		
	Total value of land.....			11,209.12
1	Buildings:			
	Dwelling, built 1884, size 35 by 50.....			2,500.00
	Tenant house, built 1884, size 35 by 25.....			788.00
	Barn, built 1870, size 90 by 20.....			2,900.00
	Potato storage, built 1913, cost \$1,325.....			1,700.00
	Shop, built 1908.....			200.00
	Henhouse, built 1908.....			178.00
	Ice house (old).....			18.00
	Smokehouse (old).....			45.00
	Hog shelter built 1914, cost \$25.....			20.00
	Total value of buildings.....			8,349.00
	Other improvements:			
	Waterworks (including windmill), built 1908.....			265.00
2	Work stock:			
	Dolly, black mare, born 1903, cost \$250.....			125.00
	Molly, gray mare, born 1904, cost \$250.....			125.00
	Jim, bay horse, born 1904, cost \$200.....			60.00
	Tabe, bay horse, born 1903, cost 200.....			90.00
	Total value of work stock.....			400.00
2	Cattle:			
	Cows.....	3		300.00
	Heifers.....	2		115.00
	Total value of cattle.....			415.00
2	Swine:			
	Brood sows.....	4		200.00
	Boars.....	2		100.00
	Shoats.....	28		550.00
	Pigs.....	8		60.00
	Total value of swine.....			900.00
2	Poultry, hens and roosters.....	52		80.00
3	Equipment (implements, tools, etc.):			
	Horse equipment—			
	Harness, double, heavy.....sets..	2		45.00
	Harness, double, light.....do....	1		3.00
	Harness, single, light.....do....	1		5.00
	Collars.....	6		8.00
	Fly nets.....sets..	3		4.80
	Whiffletrees, double and single.....do....	2		2.60

A. Sample of a complete farm inventory on a 125-acre farm in western New York—Con.

INVENTORY OF FARM PROPERTY ON THE PINE TREE FARM, MAR. 1, 1920.

Page of property book.	Property.	Quantity.	Price.	Value.
3	Equipment (implements, tools, etc.)—Continued.			
	Horse equipment—Continued.			
	Whiffletrees, triple.....sets.	1		\$1.50
	Blankets, horse.....	2		2.00
	Broom, stable.....	1		.25
	Currycombs and brushes.....	3		.80
	Total value horse equipment.....			72.05
3	Cattle equipment—			
	Separator, bought 1915, cost \$55.75.....			30.00
	Butter worker, bought 1915, cost \$3.70.....			1.75
	Fodder cutter, bought 1917, cost \$25.....			19.00
	Milk pails.....	2	\$0.50	1.00
	Total value cattle equipment.....			51.75
3	Swine equipment—			
	Feed cooker.....	1		18.00
	Self feeder.....	1		4.00
	Troughs (home made).....	8		12.00
	Total value swine equipment.....			34.00
4	Hauling and driving equipment—			
	Automobile, touring, 1919.....	1		500.00
	Top buggy (old).....	1		5.00
	Wagons, farm, 2-horse.....	2		60.00
	Truck with platform.....	1		25.00
	Bobsled.....	1		15.00
	Springs, holster.....sets.	2		3.00
	Racks, wagon (hay and stock).....	2		20.00
	Robe, horsehide.....	1		15.00
	Shoe, wagon.....	1		.50
	Slipboat, homemade.....	1		3.00
	Total value hauling and driving equipment.....			645.50
5 and 6	Crop equipment—			
	Tractor, 10 to 25 horsepower, bought 1917, cost \$1,000.....			600.00
	Plow, engine gang, bought 1917.....	1		150.00
	Disk, engine, 32-double.....	1		80.00
	Harrow, engine, 6-section, 17 feet.....	1		50.00
	Flows, walking, 12-inch.....	2		5.00
	Harrow, spring tooth.....	1		4.00
	Roller, steel, 8 feet.....	1		6.00
	Weeder, 8 feet.....	1		4.00
	Planter, bean.....	1		5.00
	Planter, potato.....	1		25.00
	Drill, grain, 11-hoe.....	1		50.00
	Sower, lime (1/3 interest).....	1		5.00
	Spreader, manure.....	1		40.00
	Seeder, grass.....	1		5.00
	Cultivators, bean, 2-horse.....	1		2.00
	Cultivators, single.....	1		1.50
	Cultivators, 2-rows.....	1		10.00
	Blinder, grain (1/3 interest).....			40.00
	Mower, 5-foot.....	1		35.00
	Rake, hay, side-delivery.....	1		25.00
	Spray rig, power, 200-gallon tank.....	1		250.00
	Digger, potato.....	1		25.00
	Grader, apple and potato.....	1		20.00
	Ladders (various sizes).....	9		10.50
	Mill, fanning.....	1		2.50
	Puller, bean.....	1		2.00
	Crates, picking.....	400	.11½	45.00
	Bags, picking.....	1		.50
	Bags, grain.....	50	.10	5.00
	Barrels, cider.....	2	.75	1.50
	Cradle, grain.....	1		.50
	Forks, barley.....	1		.45
	Forks, hay.....	4	.25	1.00
	Hoes.....	4	.25	1.00
	Press, apple barrel.....	1		.25
	Stencil, apple barrel.....sets.	1		.75
	Saws, pruning.....	2	.50	1.00
	Shears, pruning.....	1		.50

A. Sample of a complete farm inventory on a 125-acre farm in western New York—Con.

INVENTORY OF FARM PROPERTY ON THE PINE TREE FARM, MAR. 1, 1920.

Page of property book.	Property.	Quantity.	Price.	Value.
5 and 6	Equipment (implements, tools, etc.)—Continued.			
	Crop equipment—Continued.			
	Scoop, grain.....	1		\$0.25
	Scythes.....	1		.50
	Drier, seed corn, homemade.....	1		4.00
	Total value crop equipment.....			1,494.70
7	Shop equipment—			
	Anvil, blacksmith (with hardie, etc.).....	1		3.50
	Bit, $\frac{1}{2}$ -inch.....	1		.20
	Brace and bits..... sets	1		1.25
	Chisel, wood, $\frac{1}{2}$ -inch.....	1		.25
	Drawshare.....	1		.25
	Forge, blacksmith.....	1		2.00
	Grinder, tool, emery.....	1		5.00
	Grindstone.....	1		.50
	Hammers, blacksmith 00.....	2	\$0.05	.10
	Hammers, claw.....	1		.20
	Pincers, blacksmith..... sets	2	.25	.50
	Plane, wood, jack.....	1		.15
	Saw, hack, with blades.....	1		1.00
	Saw, hand.....	2	.50	1.00
	Sledge hammer, iron.....	1		1.00
	Snips, tinner's..... pairs	1		.25
	Square, steel, 2-foot.....	1		.50
	Square, bevel.....	1		.25
	Stove in shop (old).....	1		2.00
	Swivel.....	1		.25
	Vise, bench.....	1		1.00
	Wrench, machine, 18-inch (new).....	1		2.00
	Wrench, pipe, 14-inch (old).....	1		.25
	Total value shop equipment.....			23.40
8	Other special purpose equipment—			
	Evaporator, maple sirup, 11-barrel.....	1		60.00
	Buckets, and spiles, sap.....	425	.11 $\frac{1}{2}$	50.00
	Jugs, sirup.....	15	.10	1.50
	Saws, ice.....	2		1.25
	Machine, concrete.....	1		75.00
	Mower, lawn.....	1		2.00
	Can, gasoline.....	1		.25
	Can, oil.....	1		.75
	Axes.....	1		.50
	Chain, log.....	2	.75	1.50
	Desk, office.....	1		14.00
	Saw, crosscut.....	1		.50
	Scales (in barn) platform.....	1		14.00
	Truck, bag.....	1		1.00
	Total value other special purpose equipment.....			222.25
8	General purpose equipment—			
	Block and tackle.....	1		1.00
	Crowbars.....	2	.25	.50
	Forks, pitch.....	1		.40
	Mattock.....	1		.50
	Pickaxe.....	1		.20
	Shovels.....	4		.75
	Spade.....	1		.25
	Wheelbarrow.....	1		.50
	Lantern, gasoline.....	1		6.00
	Lantern, oil.....	2		2.00
	Total value general purpose equipment.....			12.10
9	Farm produce:			
	Barley..... bushels	75	1.50	112.50
	Oats..... do.	100	1.00	100.00
	Wheat..... do.	400	2.50	1,000.00
	Rye..... do.	20	1.50	30.00
	Beans..... do.	6	3.33	20.00
	Corn, ear..... bushels of ears	191	.90	171.90
	Corn, seed..... bushels	21 $\frac{1}{2}$	4.00	87.00
	Potatoes, seed..... do.	1,000	3.10	3,100.00
	Potatoes, market..... do.	650	2.15	1,397.50

A. Sample of a complete farm inventory on a 125-acre farm in western New York—Con.

INVENTORY OF FARM PROPERTY ON THE PINE TREE FARM, MAR. 1, 1920—Continued.

Page of property book.	Property.	Quantity.	Price.	Value.
9	Farm produce—Continued.			
	Straw.....tons..	2	\$2.50	\$5.00
	Fodder corn.....do..	1	10.00	5.00
	Hay, mixed.....do..	14	20.00	280.00
	Total value farm produce.....			6,308.90
10	Purchased feeds and supplies: -			
	Bran.....pounds..	600	2.50	15.00
	Middlings.....do..	200	3.50	7.00
	Tankage.....do..	1,200	5.00	60.00
	Salt.....ton..	1	8.00	1.00
	Apple barrels.....	39	.60	23.40
	Alfalfa seed, Grimm.....bushel	1	28.00	14.00
	Oil, kerosene (fuel for tractor).....gallons.	320	.17	56.00
	Oil, motor and cylinder.....do..	50	.50	25.00
	Gasoline.....do..	10	.28	2.80
	Cement.....bags..	2	.75	1.50
	Lumber.....feet..	200	4.00	8.00
	Total value purchased feed and supplies.....			213.70
11	Growing crops:			
	Wheat, Field A.....acres..	19.3	12.70	245.91
	Winter pruning, Field I.....do..	2.83	20.00	76.60
	Hay, Field K.....do..	15.7	3.00	47.10
	Winter plowing, Field L (part).....do..	5.00	4.00	20.00
	Total value growing crops.....			392.62
11	Accounts and notes receivable:			
	Jas. Smith, for 2 pigs.....			16.00
	Henry Wilson, for 10 bushels potatoes.....			30.00
	Note, H. K. Hallock, for 1 cow.....			125.00
	Total accounts and notes receivable.....			171.00
11	Cash on hand and in bank.....			257.61
12	Liabilities:			
	Mortgage on farm.....			8,000.00
	Smith's store for groceries and supplies.....			25.00
	Note at bank, due May 4.....			200.00
	Total liabilities.....			8,225.00

SUMMARY OF INVENTORIES.

12	Resources:			
	Land.....			\$11,309.12
	Buildings.....			8,349.00
	Other improvements.....			265.00
	Work stock.....			400.00
	Cattle.....			415.00
	Swine.....			900.00
	Poultry.....			80.00
	Equipment:			
	Horse.....		\$72.05	
	Cattle.....		51.75	
	Swine.....		34.00	
	Hauling and driving.....		648.50	
	Crop.....	1,494.70		
	Shop.....	23.40		
	Other special purpose.....	222.25		
	General purpose.....	12.10		
	Farm produce.....			2,558.75
	Purchased feeds and supplies.....			6,308.90
	Growing crops.....			213.70
	Accounts and notes receivable.....			392.62
	Cash on hand and in bank.....			171.00
	Total value farm resources.....			257.61
	Total liabilities.....			31,518.70
	Net farm worth.....			8,225.00
				23,292.70

B. RULES FOR ESTIMATING QUANTITIES OF PRODUCE IN BULK.

[All measurements in feet and tenths of a foot.]

To measure wheat, oats, barley, rye, buckwheat, and shelled corn in bins.—Multiply inside length and width of bin together, then multiply that product by the average depth of grain in the bin. This gives the cubic feet, which divided by 5 and multiplied by 4 gives approximately the number of bushels of grain.

To measure ear corn in bins or cribs.—For structures with perpendicular sides, multiply inside length and width together, then multiply that product by the average depth of the corn in the bin or crib. Where the crib or bin sides are flared or sloped the width must be determined by measuring both at floor and top of the corn pile. Adding these two widths together and dividing by two gives the average width measurement, which in such cases is the correct one to use. Dividing the cubic feet by 5 and multiplying by 2 gives the approximate quantity in bushels of shelled corn. For corn in the shuck, divide by 7 and multiply by 2. Multiplying the cubic feet by 8 and pointing off two decimal places gives the approximate quantity in "barrels" of ear corn. A "barrel" of ear corn is equal to 5 bushels of shelled corn or 10 bushels of ear corn, and its legal weight is 350 pounds.

To measure hay, straw, and shredded stover in the mow.—Find the cubic feet by multiplying together the length, width, and average depth of the space occupied. The number of cubic feet in a ton will vary with the length of time the product has been stored. For inventorying purposes, figures based on storage for 5 months or more can be used. In general, it will be approximately accurate to use the following figures:

To get tons of hay, divide cubic feet by 550.

To get tons of straw, divide cubic feet by 625.

To get tons of shredded stover, divide cubic feet by 675.

To measure ricks.—Measure the distance from the ground on one side over the rick to the ground on the other side. To this add width of rick at ground. Multiply that sum by itself and multiply the product by the average length of the stack. For hay that has been stacked 5 months or more divide this last product by 75 and point off two decimal places to get the approximate number of tons.

To measure stacks.—Round stacks of forage vary so greatly in the relative proportions of height and diameter, as well as in shape, that no approximately accurate simple rule can be given. In some parts of the country it is customary to put a certain average quantity of forage into each stack. Where this is done the quantities can be approximated by counting the number of stacks and multiplying by the average quantity per stack. A rule which will give fairly close figures for average-shaped stacks is to measure the vertical distance from ground to bulge, and add to this figure $\frac{1}{4}$ the vertical distance from bulge to top; multiply this sum by the circumference of the stack at the bulge and multiply the resulting product by the circumference at the ground. Dividing this last product by 12 will give the number of cubic feet, approximately. (For more exact information on measuring hay in stacks, see Circular 67, Office of the Secretary, "Measuring Hay in Ricks and Stacks.") For hay in uncovered ricks and stacks the number of cubic feet in a ton will vary from 400 to 500.

A tape line divided into feet and tenths will facilitate the measuring and computations. Where one is not available the following table, converting inches and quarter-inches into tenths of a foot, will be of assistance:

Conversion of inches into tenths of a foot.

Inches.	Tenths of a foot.	Inches.	Tenths of a foot.
0 to $\frac{1}{4}$	0	$5\frac{1}{4}$ to $6\frac{1}{4}$	5
$\frac{1}{4}$ to $1\frac{1}{4}$	1	$6\frac{1}{4}$ to $7\frac{1}{4}$	6
$1\frac{1}{4}$ to $2\frac{1}{4}$	2	$7\frac{1}{4}$ to $8\frac{1}{4}$	7
$2\frac{1}{4}$ to $3\frac{1}{4}$	3	$8\frac{1}{4}$ to $9\frac{1}{4}$	8
$3\frac{1}{4}$ to $4\frac{1}{4}$	4	$9\frac{1}{4}$ to $10\frac{1}{4}$	9
$4\frac{1}{4}$ to $5\frac{1}{4}$		$10\frac{1}{4}$ to $11\frac{1}{4}$	

Minimum legal weights of produce.—(For use where weighing is done when inventorying.)

	Pounds.		Pounds.
Corn on the cob.....	70	Cotton seed.....	30
Corn, shelled.....	56	Potatoes.....	60
Wheat.....	60	Sweet potatoes.....	54
Oats.....	32	Corn meal.....	48
Rye.....	56	Onions.....	57
Barley.....	48	Apples.....	48
Buckwheat.....	48	Turnips.....	55
Peas.....	60	Beets.....	56
Beans.....	60	Carrots.....	50

C. HINTS ON ESTIMATING THE LIFE OF FARM IMPLEMENTS.

The useful life of farm implements is governed, in general, by several factors, among which are included quality of construction and design, climate, topography, soil condition, amount of use, and quality of maintenance. It will be necessary in each case for these factors to be considered in appraising. No exact rules can be given.

The following figures taken from a department publication will prove of interest in this connection:¹

Average length of life of farm implements in western New York.

Implement.	Average years of life.	Average acres covered per year.	Implement.	Average years of life.	Average acres covered per year.
Walking plow.....	11.7	32.9	Cultivator:		
Sulky plow.....	8.1	30.9	1-row.....	14.0	16.9
Springtooth harrow.....	11.0	71.1	2-row.....	12.5	39.3
Spiketooth harrow.....	14.0	46.3	Cabbage transplanter.....	12.8	12.5
Disk harrow.....	13.0	35.2	Mower.....	14.8	28.0
Land roller.....	16.0	65.9	Hay rake.....	14.5	43.0
Grain drill.....	16.4	46.3	Hay tedder.....	14.0	21.6
Corn planter:			Bean harvester.....	12.9	16.9
1-row.....	11.7	4.1	Grain binder.....	15.4	35.2
2-row.....	11.0	8.2	Corn binder.....	10.8	21.1

These figures should be more or less useful in appraising machinery. It should be borne in mind that the area from which these figures were secured has a moist climate, is mostly level, and that the soil types are generally rather heavy and reasonably free from stones. Where the soil is either very light or unusually heavy or stony due allowances should be made.

The figures shown in the following table will be found useful in placing values on implements. To use the table, find in the left-hand column the figure indicating probable total length of life of the implement under consideration, then on the bottom line find the figure representing the years it has already been used. The figure at the junction of column with line will represent the value of the implement at the end of the year expressed in per cent of the original cost. For example, for a machine costing \$10 that has a probable total life of 15 years and has been used for 7 years, find in the left-hand column the figure 15, and on the bottom line the figure 7. At the place where the line opposite the 15 and the column above the 7 come together will be found the figure 53.3, which means that after 7 years of use the implement is worth 53.3 per cent of its first cost, or in this case \$5.33.

¹ Mowry, H. H., Machinery Cost of Farm Operations in Western New York: U. S. Department of Agriculture Bulletin 338.

are shown in percentage of first cost.

Length of life, Years.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	Years of use.
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FARMERS' BULLETIN 1183
UNITED STATES DEPARTMENT OF AGRICULTURE

THE CARE OF LEATHER



This bulletin contains suggestions for a judicious selection of articles made from leather and tells how to care for them in order to obtain the maximum service.

Contribution from the Bureau of Chemistry

W. G. CAMPBELL, Acting Chief

Washington, D. C.

**Issued December, 1920
Revised February, 1922**

THE CARE OF LEATHER.

F. P. VEITCH, *Chemist in Charge*, H. P. HOLMAN and R. W. FREY, *Assistant Chemists, Leather and Paper Laboratory.*

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INTRODUCTION.

FOR several years the supply of leather in this country has barely met the demand, even with an annual importation of hides and skins nearly equal to the domestic supply. The people of the United States buy about 300,000,000 pairs of shoes a year. Their needs could be supplied by 250,000,000 pairs, if they were well cared for and kept in repair. As a rule the farmer uses his harness for less than 10 years. If the right kind of attention were given to its manufacture and use, it should last for 20 years or longer. Belts for driving machinery often become impaired, if not useless, within a few years, even on straight drives. A good leather belt, suited to the work to be done and properly installed, will run for from 10 to 30 years.

Every pair of shoes, every machine belt, and every piece of harness that is allowed to go to waste or that is not made to yield full service must be needlessly replaced by other leather, thus keeping prices high. Including leather made from imported hides, the leather supply in this country is large enough to provide everyone with an average of two or even two and one-half pairs of shoes a year and to keep them in repair, as well as to replace all harness and machine belts every 10 or 20 years, at reasonable prices. It is doubtful, however, whether the leather-making materials produced here, supplemented by those which can be imported, will suffice to meet the demand for three or more pairs of shoes a year for each person, for a new harness

every 2 or 5 years, and for new machine belts every 5 or 10 years, which is now too frequently the requirement.

The suggestions and directions given in this bulletin, if followed by the public, will go far toward conserving the supply of leather, and will materially reduce the individual expenditures for leather goods.

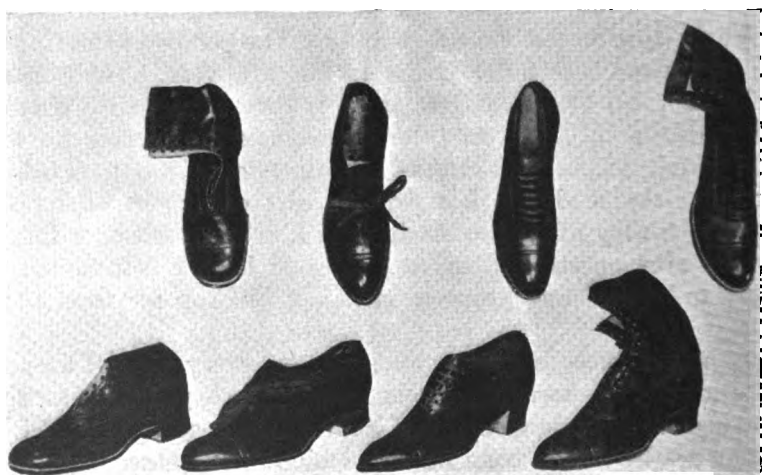
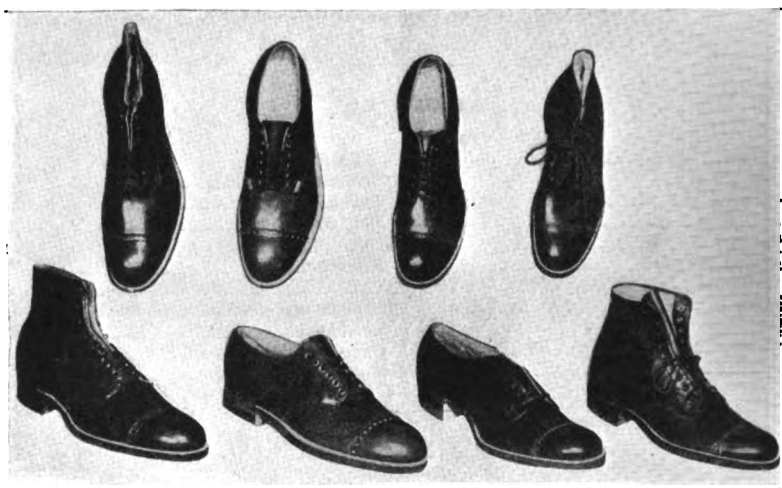


FIG. 1.—Attractive Shoes of Good Shape.

They combine comparatively straight inner lines, rounded toes, heels of medium height, and moderately thick soles, all of which make for greater serviceability, comfort, and safety.

BOOTS AND SHOES.

The wasting of a single shoe a year by each person in the United States costs the country at least \$250,000,000 annually, at the present prices.

SELECTION.

The frequent occurrence of such troubles as corns, bunions, overriding and hammer toes, fallen arches, and calloused, swollen, and aching feet indicates that too often insufficient care is given to the selection of shoes. Feet which are forced into shoes that are too

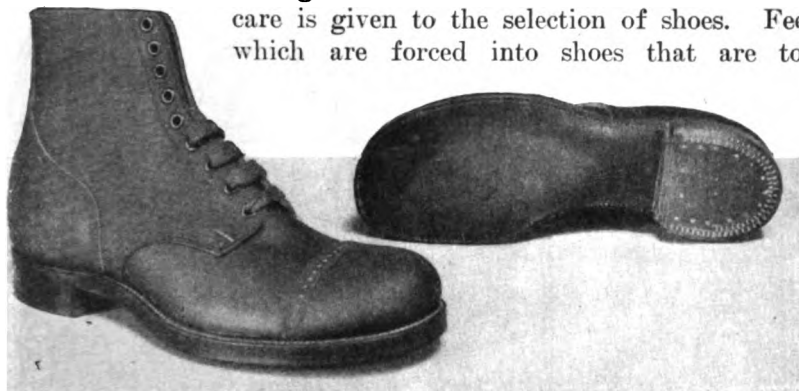


FIG. 2.—Shoes for Every-day Wear.

A serviceable type, insuring maximum comfort and efficiency for the wearer, and well adapted for use in city and country alike. After a thorough study the War Department adopted this style of shoe for the U. S. Army.

small for comfort or fail to conform to the natural shape of the foot are cramped and twisted and, if such shoes are worn continuously, the bones become deformed, as shown in figure 4. Though it is possible now to buy footwear which combines the proper shape with an attractive appearance and good quality of material (fig 1), a more universal demand for such shoes will increase the supply. These shoes are more comfortable and more serviceable than those which do not conform to the natural shape of the foot, and, aside from giving bodily ease and longer wear, they save money which might otherwise be required for the alleviation of foot troubles.

Feet which have become distorted by improperly fitting shoes may need remolding by a series of gradual changes. The habitual wearer of high heels probably will find low heels uncomfortable for a week or so, because such heels bring into service muscles which have long been inactive, while relieving the strain on others trained to balance the body in an unnatural position. Likewise, it may be more satisfactory to go by easy stages from a narrow, pinching toe to one that will permit the foot to spread out to its natural size.

Shoes with heels which throw the wearer's weight upon the toes or are too small to support solidly the weight of the body lose their attractive appearance and their serviceability much more quickly than those with heels which permit the feet to maintain their normal position in standing and walking. Heels which are too small or too high or are placed forward under the foot have a tendency to become worn down on one side, which causes excessive strain on the seams and uneven wear on both the soles and uppers. Of more

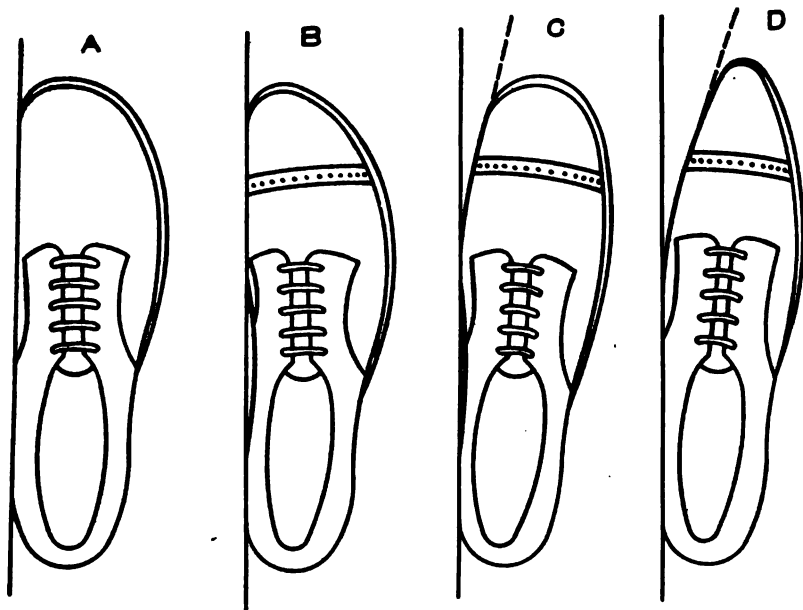


FIG. 3.—Comparison of Shoes Made on Proper and on Improper Lines.

A and B—Satisfactory. Note the straight inner line and rounded toe characteristic of the normal foot. *C and D*—Objectable. Note the curve outward from the naturally straight inner line of the foot; also the too pointed toe *D*. (Photograph from the Army Medical Museum.)

importance, however, is the fact that such heels are a constant menace to the health of the wearer, and frequently cause serious injury through slipping and falling. Rubber heels, the use of which has become very general, are often advisable for wear in the city, where they lessen the jar in walking, and, as a rule, last longer than leather heels.

If the soles of shoes designed for ordinary use are sufficiently thick they protect the feet against injury from uneven surfaces, give comparatively long service, and help to maintain the shape of the shoe. Thin or soft soles may cause the feet to become calloused, bruised, or strained, and afford little protection to the wearer in wet weather.

Welt shoes can be resoled or half soled by sewing more easily and neatly than other kinds. In this type of shoe, a strip of leather

called the welt is used to join the soles to the upper. The welt is sewed to the inner sole and upper along its inner edge and to the outer sole along its outer edge. It should extend for at least a quarter of an inch beyond its juncture with the upper, and preferably should be smooth. Narrow welts and welts finished by wheeling (fig. 6) often break and make repairs difficult and expensive.

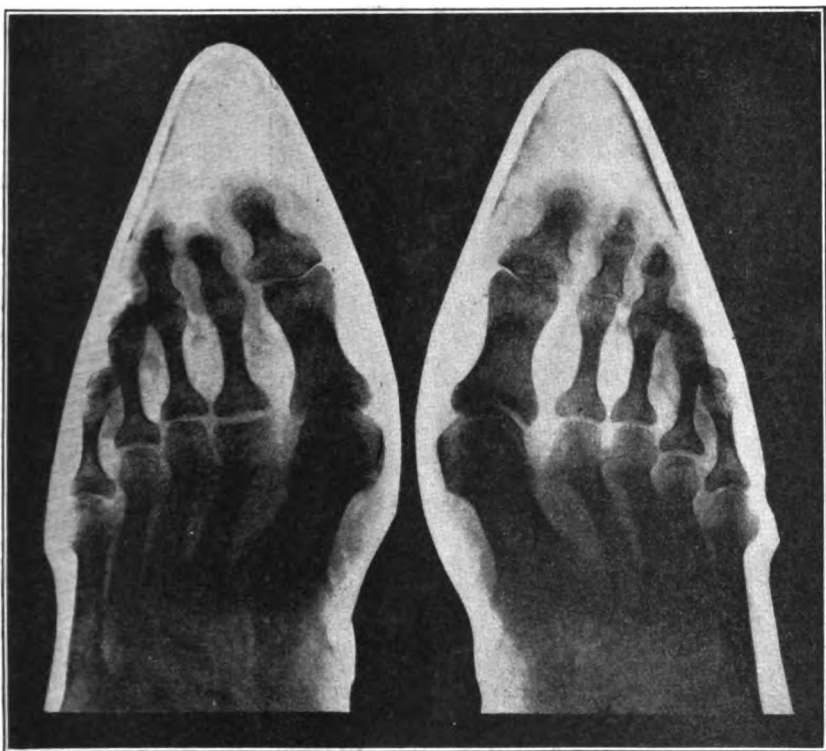


FIG. 4.—Effect of Shoes on the Bones of the Foot.

The bones of the foot bent into unnatural and often painful positions by improperly shaped and ill-fitting shoes. (Photograph from Army Medical Museum.)

CARE.

Proper care of shoes means a reduction in shoe bills of from 25 to 50 per cent, and at the same time insures good-looking footwear. An economical plan is to have two pairs which are worn on alternate days, thus permitting each pair to become thoroughly dry between the periods of wearing them. Shoe trees are of great assistance in retaining the original shape of the shoe. Shoes designed for farm or other heavy out-of-door work should be kept clean and greased, while those for street wear should be kept clean and polished.

Send your boots or shoes to the shoemaker for repairs the minute they begin to rip at the seams, the upper leather cracks through at a crease, a heel becomes twisted out of shape, or the heel lift wears through. Especially avoid wearing away the welt. Delay may mean that the shoe soon will be so badly damaged that it is no

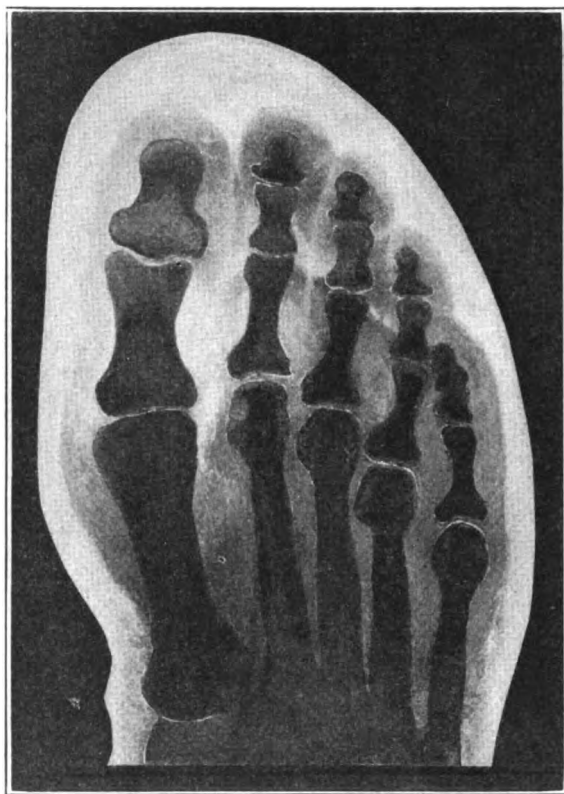


FIG. 5.—Effect of Shoes on the Bones of the Foot.

The nearly normal bone structure of a foot in a correctly shaped and properly fitting shoe. (Photograph from Army Medical Museum.)

thread, bristles, and wax. Made-up repair kits containing all the necessary articles, or the separate articles, can be purchased from dealers in hardware or shoe findings. Waxed linen or flax thread should always be used for sewing, the flax being stronger and more durable than cotton, and the wax making the thread more water-resistant and the stitch holes more impervious to water.

DRYING.

Boots and shoes are peculiarly subject to damage after they have become soaking wet while being worn. The wet leather is soft and therefore readily stretches out of shape. The stitches cut through wet leather much more easily than through dry leather, and wet soles and heels wear away rapidly.

longer worth repairing, and from \$2 to \$5 has been lost by neglect (figs. 7 and 8).

Ripped seams in the uppers can frequently be stitched at home, and a handy man, with the aid of a repair kit, can put on new heel lifts, rubber heels, half soles, and metal heel or toe plates without much difficulty. The equipment necessary for repairing shoes includes a last holder, three or four iron lasts of different sizes, a shoemaker's hammer, a pair of pincers, one or two leather knives, a leather rasp or file, awls, nails for soles and heels, flax shoe

Great care must be taken in drying wet boots and shoes, for they often burn before it seems possible. If wet leather, which burns much more readily than dry leather, becomes hotter than the hand can bear, it is almost sure to burn. Moreover, if dried too fast and without sufficient attention, the shoes shrink, becoming hard and misshapen.

To dry wet boots and shoes properly, first wash off all adhering mud and grit with tepid water, and, in the case of work or rough shoes, at once oil or grease them with one of the preparations described on page 12. Then straighten the counter heel, vamp, and

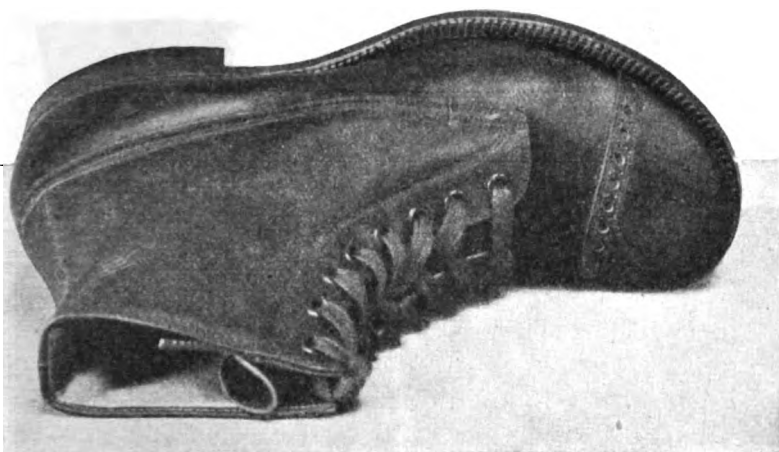


FIG. 6.—Shoe with Wheeled Welt.

These corrugations, produced by "wheeling," weaken the welt and render defective stitching less apparent.

top to the correct shape, and stuff the shoes with crumpled paper, which helps to hold the shape and shortens the drying period. Finally, set the shoes aside in a place that is not too warm and allow them to dry slowly. The shoes should not be worn until they have become thoroughly dry.

OILING AND GREASING.

The rational use of suitable oil or grease greatly increases the endurance of shoe leather. Boots and shoes, especially those worn on the farm, in the forest, and in mines, should be oiled or greased whenever the leather begins to harden or dry, or when it does not turn water well. The purpose of doing this is to make the boots last longer, and to keep the feet dry and comfortable.

Before oiling or greasing, brush the boots or shoes thoroughly to remove all the dirt and dust, warm them carefully, bearing in mind the danger of burning them if they are wet, and apply warm oil or grease with a swab of wool or flannel. The oil or grease should

never be hotter than the hand can bear, and it should be rubbed well into the leather, preferably with the palm of the hand. Special care should be taken to work the grease in well where the sole is fastened to the upper, as the water soaks in most frequently at that place. After being greased the shoes should be left to dry in a warm, but not hot, place.

Among the best materials for this purpose are neat's-foot, cod, and castor oils, tallow, and wool grease, or mixtures of them. Cylinder oil and vaseline or petrolatum also are good, but are improved by being mixed with animal oils or greases. The application of any oil or grease darkens light-colored or russet leather. Where this is objectionable the shoes should be kept in good condition by frequent polishing.

Castor oil probably is the most satisfactory oil for use on shoes

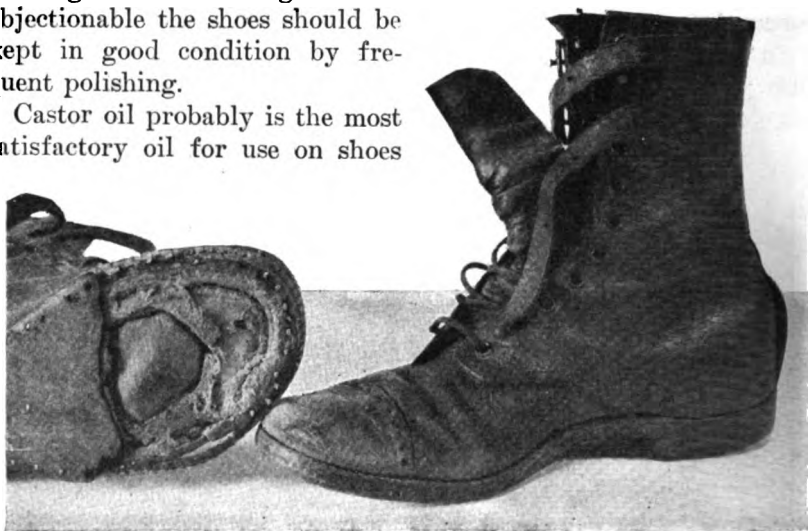


FIG. 7.—Repairing always should be done in time, certainly before the welt and insole become worn. Ordinarily it does not pay to repair shoes like these.

that are to be polished. Apply the oil lightly to the clean, dry shoe, and rub it into the leather until dry. If the application is light the shoe may be polished immediately, although it is better to wait until the next morning. Too heavy an application makes it difficult to polish the shoes satisfactorily, even after two or three trials.

WATERPROOFING.

The ideal shoe would permit the perspiration from the foot to pass out, at the same time preventing the entrance of water. Such a shoe, however, does not exist.

Dependence for keeping the feet dry must, then, be placed on rubber overshoes and boots or waterproofed leather shoes and boots. Although rubber overshoes and boots keep water out, they also keep the perspiration in. Moreover, they are cold in winter and hot in summer. For these reasons, as well as because of excessive weight, rubber footwear is objectionable to many people.

Some boots which are well made of the best quality leather and which are properly treated are practically waterproof under most conditions of wear. Nearly all of the leather shoes and boots made nowadays, however, even when treated to make them water-resistant, allow the entrance of some water, owing principally to the difficulty of completely waterproofing the seams. Such footwear can not be expected to keep the feet perfectly dry if worn for a long time in wet weather, nor will it take the place of rubber overshoes or boots for walking in water, slushy snow, or very soft mud. Nevertheless, waterproofed leather boots and shoes are very satisfactory for protecting the feet during rain or snowstorms and for use on wet pavements or wet ground where there are no

deep puddles. They

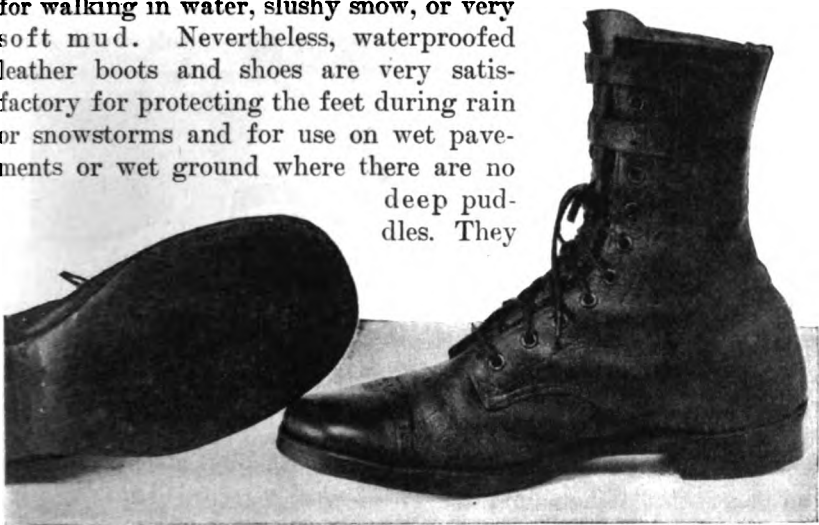


FIG. 8.—Nevertheless, for \$2 these shoes were put into excellent shape and were worn for another three months.

also keep the perspiration in, but are less objectionable than rubber in this respect.

As already stated, applications of oil or grease to light-colored and russet leather darken it and make all leather difficult to polish. Where this is an objection, only the soles of the shoes need be waterproofed. The uppers can be made fairly water-resistant by frequently applying a good wax polish. The occasional use of castor oil on uppers increases their water-resistance, flexibility, and durability, without greatly detracting from their ability to take a polish. If the oil is applied lightly to a clean, dry surface and rubbed in until the leather is dry, the shoes may be polished immediately, although better results are obtained by waiting until the next day. If the oil is applied too heavily, it is difficult to polish the shoes and the shine will not last long. The best method is to pour a little oil on a piece of felt or cheesecloth, work in the hands until the oil is thoroughly distributed, and then rub the cloth lightly and evenly over the leather.

The grease used for waterproofing shoes and boots in summer should be harder than that used in winter. Since heavily greased shoes have a tendency to cause the feet to perspire and swell in hot weather, and there is also less need for water-resistant shoes in summer and spring, it is rarely advisable to put as much grease on the shoes at that time of the year. In summer, the quantity of

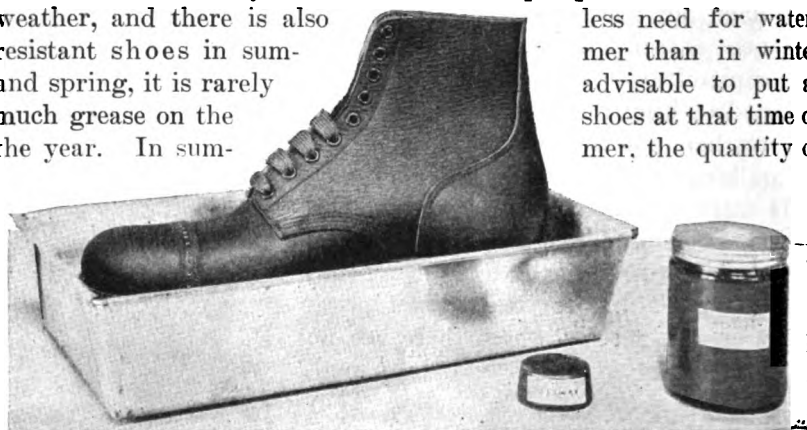


FIG. 9.—All You Need for Waterproofing Shoes.

grease used should not exceed the quantity that the leather will take up without leaving its surface greasy. In winter, especially if the maximum water-resistance is desired, a mixture of grease and oils which is not too hard when cold is required. More of this grease than the leather will absorb may be used. An excess does no harm and makes the leather more water-resistant.

WATERPROOFING FORMULAS.

For waterproofing boots and shoes, nothing better than the following simple formulas is known to the Department of Agriculture. While the department believes that these formulas infringe on no existing patents or pending applications for patents, it can assume no responsibility in the matter.

Formula 1.

Neutral wool grease.....	ounces..	8
Dark petrolatum.....	do.....	4
Paraffin wax	do.....	4

Formula 2.

Petrolatum	pound..	1
Beeswax	ounces..	2

Formula 3.

Petrolatum	ounces..	8
Paraffin wax.....	do.....	4
Wool grease.....	do.....	4
Crude turpentine gum (gum thus)	do.....	2

Formula 4.

Tallow	ounces..	12
Cod oil.....	do.....	4

In each case melt the ingredients of the mixture together by warming them carefully and stirring thoroughly. Better penetration is obtained if the grease is applied warm, but it should never be hotter than the hand can bear.

Grease thoroughly the edge of the sole and the welt, as this is where shoes leak most, and completely impregnate the sole with the grease. The sole can be most conveniently waterproofed by letting the shoe stand for about 15 minutes in a shallow pan containing enough of the melted waterproofing material to cover the entire sole. Rubber heels, however, should not be allowed to stand in the grease, as it softens the rubber.

POLISHING.

Most of the modern shoe polishes consist of mixtures of waxes colored with dyes and softened to a pasty consistency, usually with turpentine. Others which contain no turpentine are made from an emulsified mixture of waxes, formed by boiling them with a solution of borax or soda, colored with dye or finely pulverized bone charcoal, and mixed either with a solution of ordinary soap to form a paste or with a solution of castile soap to form a liquid. Some liquid polishes consist of shellac, waxes, and dye in alcohol solution.

The general belief that the presence of turpentine in shoe polishes is injurious to leather is not borne out by experiments on various polishes of this kind. The turpentine in polishes sometimes becomes rancid, acquiring a sharp, disagreeable odor and making the polish gummy. Such polishes give less satisfactory results than those in which the turpentine is sweet.

Polishes which contain free acid or alkali may be harmful. Some polishes of the emulsion type which contained free alkali, examined in the laboratory, caused cracking of the vamps where the shoe is most often bent. Liquid cleaners which contain oxalic acid, often put up in combination with paste polishes for use on light-colored shoes, usually injure leather. It is possible to detect the presence of free acid or alkali, in a polish which does not contain water-soluble dye, by stirring up some of the polish with warm rain water and testing the clear water after settling with red and blue litmus paper. A change from red to blue indicates free alkali, while a change from blue to red indicates free acid. If the polish contains water-soluble dye, free acid and alkali can be detected only by chemical analysis.

HARNESS.

According to the reports received by the department, many farmers obtain excellent service from their harness for 25 years (fig. 10), but many others are unfortunately unable to use theirs for more than

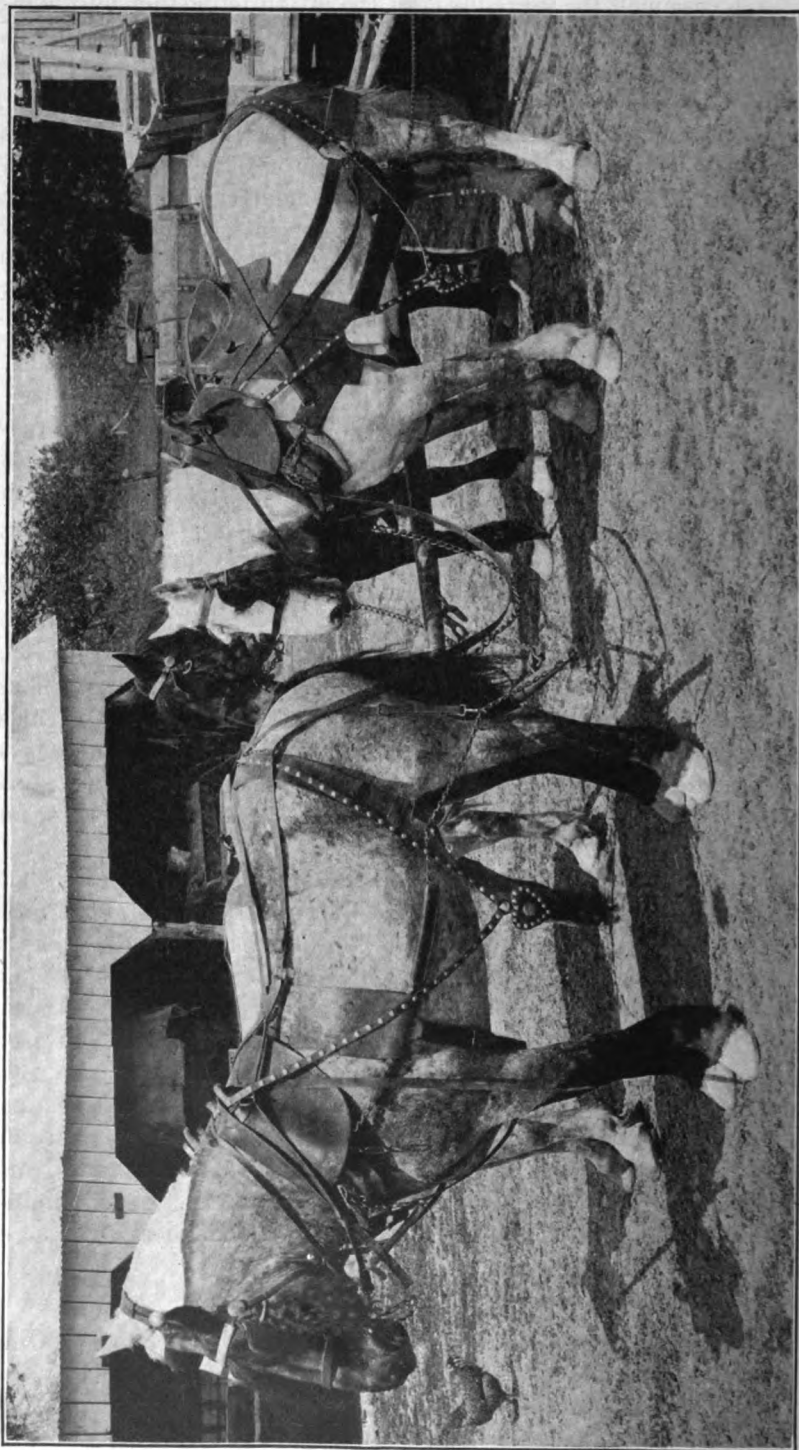


FIG. 10.—Harness Used on a Farm for 34 Years.

It has been kept clean and oiled frequently with neat's-foot oil. As a result, it shows no signs of deterioration and should last for 20 years longer. Proper selection and care did it.

from two to five years. This shows the importance of careful selection and care.

SELECTION.

In selecting harness see that it is well made. Make sure especially that the reins, breeching, holdback straps, tugs or traces, belly bands, and yoke straps are sufficiently heavy and strong for the work required. A runaway team can not be controlled with weak reins, nor will weak tugs and straps stand heavy work.

New harness that shows cracks on the grain side when the leather is sharply bent in any portion is worthless, and the presence of cracks in old harness proves that it is deteriorating and will soon fail if subjected to heavy loads.

Since strong acids prove injurious to leather in time, it is to the purchaser's best interest to buy harness which does not contain such materials. Grease in moderate quantities, up to 20 per cent, protects, preserves, and strengthens harness leathers. More than 25 per cent is not necessary.

It is more economical to buy harness that is too heavy than to buy that which is too light for the work.

CARE.

Neglect of harness results in injury that greatly lessens its durability. The sewing, which should have been done with strong waxed linen thread, must be kept in good condition. All buckles should remain solidly in place. It is advisable to wash and oil harness frequently.

For washing, use tepid water, a neutral soap, such as castile or white toilet soap, and a sponge or fairly stiff brush. Hardened grease is very conveniently removed by scraping with a dull knife. Rinse in clean, tepid water, and allow the harness to hang in a warm place until it is no longer wet, but still damp. Then oil it and leave it in a warm place for 24 hours before using it. Harness should be oiled or greased while still damp; otherwise, it may take up so much grease that it will pull out of shape or take up sand and grit, which will injure it, as well as spoil its appearance. Harness should never look or feel greasy.

For driving harness neat's-foot or castor oil or a mixture of these with wool grease is good, and for heavy harness a mixture of tallow and cod oil, neat's-foot oil and tallow, or any or all of these with wool grease, to make a paste having about the consistency of butter. Apply the grease lightly to driving harness and liberally to work harness. Rub the oil or grease, warm to the hand, thoroughly into the leather while it is still damp from the washing. After the harness has hung in a warm room overnight, remove, with a clean, dry cloth, the excess of oil which the leather is unable to take up.

If the oils and greases mentioned are too expensive or too difficult to obtain, they may be mixed with not more than an equal quantity of heavy mineral oil, petrolatum, or paraffin, or a mixture of these substances.¹ The use of any grease or other preparation containing mineral acids or oxalic acid hastens the rotting of the leather.

Should any part of your harness break under circumstances that indicate leather of poor quality, you are asked to send about 1 foot of the broken strap to the Bureau of Chemistry, United States Department of Agriculture, Washington, D. C., with a full and careful statement as to how long you have had the harness, what care you have given it, and the conditions under which it broke.

DRIVING BELTS.

Kept in good operating condition, a belt will run for from 10 to 25 years or longer, provided, of course, it is made from good materials and is adapted to the use to which it is put (fig. 13).

SELECTION.

Leather best suited for belting is cut from the section of the hide which extends for from 15 to 18 inches on each side of the backbone and from the root of the tail for about 48 or 50 inches toward the shoulder. This area is known as center stock. Leather from other sections of the hide, while strong, is more stretchy and less durable than the center-stock leather, and can not be expected to give as long service.

In selecting a belt for driving machinery the character and continuity of the work expected of it should be taken into account. The selection of the proper belt for a given installation involves consideration of load, width, thickness, length, speed, ply, size of pulleys, and horsepower. Ordinarily the competent belt maker's advice as to a suitable belt for a given installation should be followed.

It is more economical to use a belt that is too wide than one that is too narrow. If the belt is not suited to the work it gives trouble continually, causing shutdowns of machinery that will quickly cost more in loss of time and wages than many good belts.

A belt should be sufficiently flexible to cling closely to the smallest pulley over which it passes; otherwise it is not adapted to the work, and, in addition to causing loss of time from frequently running off, it may crack on the grain within a short time, which weakens it and causes it to stretch (figs. 11 and 12). Furthermore, it will slip on the pulley, thus losing power and becoming heated, which hastens its deterioration. A belt should run slack rather than tight.

¹ Castor oil will not mix well with mineral waxes, such as petrolatum or paraffin.

When new, a good belt evidently contains grease but is not greasy. It is flexible and feels firm, mellow, and smooth.

A high glossy finish causes the belt to slip until it is worn off, and in slipping it is heated, possibly burned. An oil finish is desirable, but the manufacturer seldom ships belts thus finished for the reason that oil darkens them, thus adversely affecting their sale, in spite of the fact that color is of no essential value. For the sake of a light color, therefore, belts are deprived of a final touch which would make them more pliable and keep them in prime condition for a comparatively long time. Uniform light colors and glossy finishes are often obtained at a sacrifice of valuable properties.

"Shimming," or the introduction of thin strips of leather between plies of a double or triple belt to bring it to uniform thickness, is

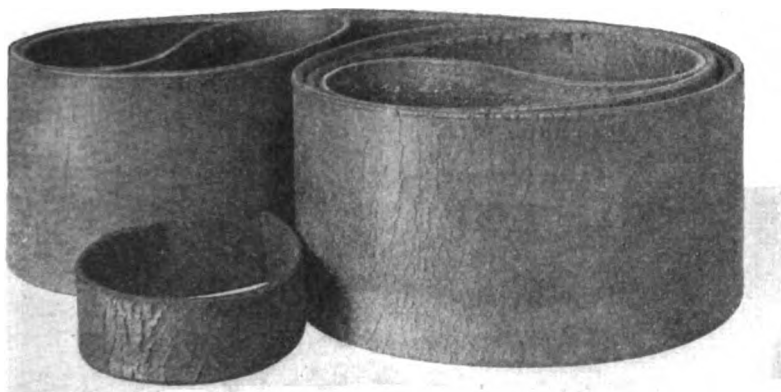


FIG. 11.— Result of Lack of Care or of Poor Quality of Leather Belting.

Carelessness causes belts and straps quickly to become cracked and weak, which results in much annoyance and delay from frequent breaking.

open to the objection that it adds extra cemented joints, any one of which may come apart and seriously interfere with the running of the belt. Proper selection of strips and overlapping of joints make shimming unnecessary. Obviously a belt is no stronger than its weakest joint. With good material and careful workmanship a joint may be practically as strong as the rest of the belt.

CARE.

Adequate service can not be expected from a belt that slips, does not run true, is not properly laced, is run too loose or too tight, is subjected to rapidly alternating light and heavy loads, is alternately wet and dry, is run on pulleys that are not true or are too small for its weight and thickness, or is neglected and allowed to deteriorate for lack of grease. An effort should be made to keep a good belt in its original condition, and prevent it from becoming hard and harsh.

Once a belt loses its original good properties, no amount of artificial dressing can fully restore them. Keep the belt clean and free from excess of grease and belt dressings. Unless frequently wiped off, dust and dirt work into the belt and damage it. Never let the belt remain dirty or dusty overnight, or leave an excess of grease or oil on it. Belts to be stored should be placed on open shelves in a well-ventilated room.

BELT DRESSINGS.

In service a belt gradually loses a portion of its lubricating material, so that, unless this is renewed at suitable intervals, its durability is impaired. A good belt grease or dressing gives the belt sufficient flexibility and at the same time causes it to cling to the

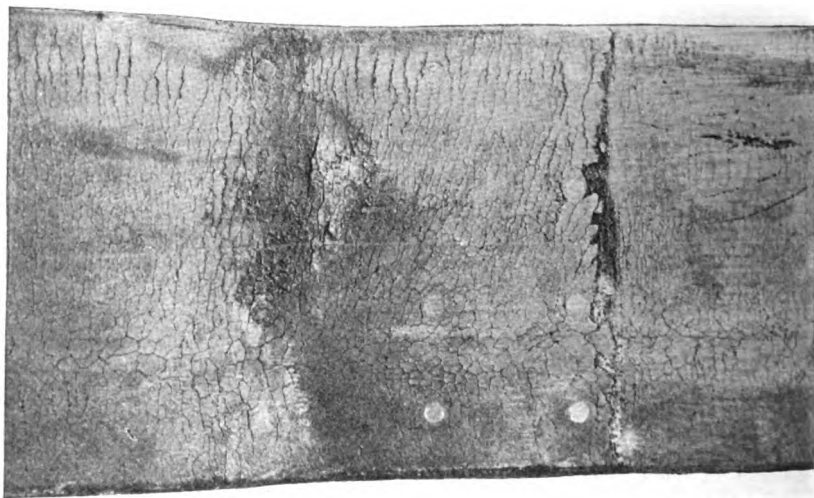


FIG. 12.—Result of Inattention and Poor Installation of Belting.

Unless kept clean, mellow, and in good condition with suitable belt dressings, a belt will soon look like this.

pulley, but does not subsequently stiffen or injure it in any way. Among the best belt dressings are mixtures of cod and neat's-foot oils with tallow and wool grease, free from mineral acid.

Clean the belt well, especially on the pulley side, by washing it with warm water and a good neutral soap, such as castile or white toilet soap, and, if necessary, scrape it on the pulley side to remove dressing and dirt that may be caked there. Wash rapidly and under no circumstances permit the belt to become wet, as it will then stretch and slip and the cemented laps may become loosened. Caking of dressings is injurious to the belt and also causes it to run unevenly. Apply the dressing, which may be either liquid or solid at ordinary temperature, to the outside of the belt while it is at rest, and allow it to soak in overnight. It should be applied very evenly and rubbed

in with cotton waste, a piece of felt, or some similar material. If absolutely necessary, a very light dressing may be applied to the pulley side of the belt, using cotton waste or felt lightly greased with the dressing. Even distribution and penetration should be secured as far as it is possible to do so. Rosin or greases containing rosin weaken the belt and shorten its period of service. Excessive amounts of belt dressings cause undue stretching and loss of grip. Belts should never feel greasy or look more greasy than when they were installed. Because a little dressing is a good thing for belts it does not follow that more is better.

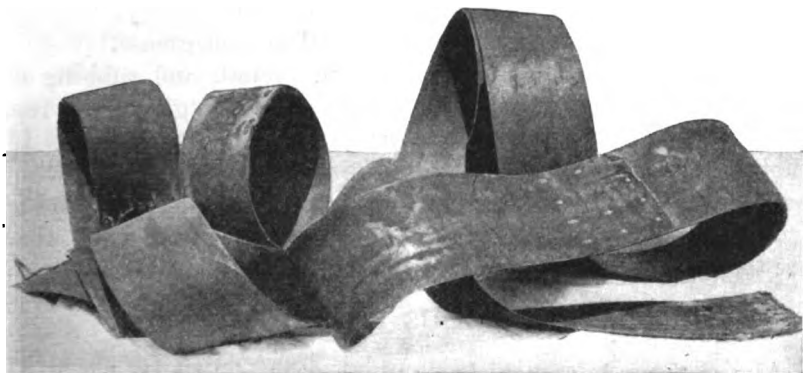


FIG. 13.—Effect of Proper Care on Leather Belting.

This belt, which has been kept in good condition, has run every day for 27 years in a country mill. Even now, when it breaks, it usually is where it has been riveted, and not where it is laced or glued.

BOOKBINDING LEATHER.

SELECTION.

Leather used for bookbinding must contain little if any mineral or oxalic acid, a small percentage of which will rot the leather in a few years.

Bookbinding leathers tanned with sumac or similar tanning materials are more durable than those tanned with hemlock bark or tanning materials of like nature.

CARE.

Bookbinding leathers have a tendency to dry out and become rather harsh, finally breaking at the hinge, if the leather along this line is not kept flexible by occasional greasing. For this purpose any high-grade vaseline or petroleum product, free from acids, may be used. The following directions for greasing bookbinding leathers are taken from the 1911 pamphlet on leather preservation issued by the Worcester County Law Library, Worcester, Mass.

The work should be done in a well-lighted, airy place, preferably during the summer months when the windows can be open to let in the outside air to supplement artificial heat for drying. Place the book, back up, on a table having a smooth top and anoint the back, rubbing the vaseline well into the grain of the leather. Next treat the sides and edges, being careful not to get any vaseline on the paper. Use small quantities of vaseline and rub them in well, with a firm, flexible stroke. The first application usually is absorbed rapidly. Next apply a second lot and rub the leather down well as before. The back and edges of the back require more vaseline than the sides and front edges. Then place the book on a shelf to dry, which takes from 24 to 48 hours, and finally rub off all surplus grease.

Merely dabbing on the vaseline with a cloth and rubbing it off again, while better than no treatment, does not give good results. Neither is one application left to dry in by itself satisfactory. Light rubbing with cloth pads will not take the place of rubbing with the bare hand. It is better to start with a very small quantity and make several applications, according to the condition of the book, than to use too much vaseline at first.

MISCELLANEOUS LEATHER GOODS.

Almost every household has a number of articles made wholly or in part from leather, among which may be mentioned traveling bags and suit cases, shopping bags, purses, pocketbooks, wallets, and bill folds, brief cases, shawl straps, belts, gloves, and furniture upholstered in leather.

SELECTION.

Paying a higher price for leather of good quality is more economical than buying leather of inferior quality at a lower price. Buying from a reputable firm is a good rule for the average person who is unable to judge correctly the quality of finished leather articles or determine the kind of skins from which they are made. In the case of bags, folders, pocketbooks, brief cases, and other articles subject to abrasive wear, leather gives better service and retains its original appearance longer when it has a smooth, rather than an embossed, finish. Moreover, a close examination of a smooth-finish leather shows whether it is a grain or a split piece, an important thing to know, as the grain leather is more serviceable. In grain leather the many fine hair holes of the skin are apparent and their arrangement may serve to identify the skin.*

* An idea of the characteristic appearance (under slight magnification) of leather made from different kinds of skin may be obtained from U. S. Department of Agriculture, Bureau of Chemistry Circular 110, "Identification of Tanned Skins," sold by the Superintendent of Documents, Government Printing Office, Washington, D. C., for 5 cents a copy.

In the case of articles made of undyed russet leather, the darker shades usually give the best service. Light-colored leather soon becomes soiled and, as a rule, has been bleached by chemicals which may be retained to its detriment.

CARE.

Leather articles of this type should not be allowed to get wet. It is best to carry billfolds, wallets, and pocketbooks where they will be subjected to the least amount of rubbing and bending and least exposed to perspiration. Leather articles should not be kept in very warm places, as leather that has become excessively dry is harsh, cracky, and easily scuffed. The life of uncoated grain leathers may be preserved and drying out prevented by the occasional application of a good saddle soap or leather dressing. The mixture described under formula 1, page 12, if thinned down, while in a molten condition, with an equal volume of turpentine and used cold, or, perhaps more conveniently, castor oil or vaseline may be used for traveling bags, suit cases, brief cases, and upholstery leather. Russet leather, however, is somewhat darkened by such treatment. Apply a little dressing on a piece of soft cloth, work it in well with the hands until thoroughly distributed, and then rub the cloth lightly and evenly over the entire surface. After a short interval rub the article briskly with a clean, dry cloth to remove any excess of grease.

Oils and greases should never be used on glazed, enameled, or coated leathers, as the coating thus treated tends to become soft and sticky. For such leather, which is sometimes used for carriage and automobile upholstery, special dressings, designed to renew the finish and improve the appearance, can be bought on the market under the name of top and seat dressings.

Sometimes it is desirable to improve the appearance of worn leather articles by the application of a coat of dye. This should be done before any dressing has been applied and preferably after the leather has been cleaned by brushing or rubbing very lightly with a small cloth moistened with gasoline. Leather dyes, sold primarily for dyeing shoes, are often expensive. Dyes for brown and black upholstery and other leather may be prepared according to the following formulas:

Brown dye.—Dissolve in $1\frac{1}{2}$ pints of water $\frac{1}{2}$ ounce of Bismarck brown, 3 grains of ethyl green (brilliant or emerald green) crystals, and $\frac{1}{2}$ ounce of phosphine (leather yellow).

Black dye.—Dissolve in $1\frac{1}{2}$ pints of water $\frac{1}{2}$ ounce of water-soluble nigrosine.

Commercial leather dyes which contain nitrobenzene, a poisonous chemical characterized by an almond-like odor, should be used only

where the ventilation is good and never should be applied to shoes on the feet.

Soiled leather may be cleaned by applying saddle soap with a moist sponge and rubbing with a clean, dry cloth. Oxalic acid, which is used sometimes alone and sometimes in preparations for cleaning and bleaching leather, is injurious. Although it is almost impossible to remove oil and grease spots from leather, in some cases satisfactory results may be obtained by coating the spot with a thick and quick drying rubber cement and peeling off the coating when it is almost dry. It may be necessary to repeat this operation several times.

MILDEWING OF LEATHER.

Any leather article is almost certain to mildew if kept in a warm, damp, and dark place, such as a closet, cellar, or stable. This mildewing probably will not reduce seriously the serviceability of the article, unless it is allowed to remain too long. It may, however, change the color appreciably, thus injuring the appearance. The simplest way to prevent mildewing is to keep the leather in a well-ventilated, dry, well-lighted place, preferably one exposed to the sunlight. When mildew develops, it should be washed off with soap and warm water, or simply wiped off with a moist cloth, drying the leather well afterwards. These simple measures are more satisfactory than the application in the home of preparations designed to prevent the growth of mildew.



FARMERS' BULLETIN ~ **1184**
UNITED STATES DEPARTMENT OF AGRICULTURE

GINSENG CULTURE



GINSENG is a fleshy-rooted herbaceous plant native to this country and formerly of frequent occurrence in shady, well-drained situations in hardwood forests from Maine to Minnesota and southward in the mountain regions to Georgia and the Carolinas.

When placed under culture ginseng should be shielded from direct sunlight by the shade of trees or by lath sheds. The soil should be fairly light and well fertilized with woods earth, rotted leaves, or fine raw bone meal. Seed should be planted in the spring, as early as the soil can be worked. Only cracked or partially germinated seed should be used. Ginseng needs little cultivation, but the beds should at all times be kept free from weeds and grass. A winter mulch over the crowns is usually essential.

The roots do not reach marketable size until about the sixth year from seed. When dug they should be carefully washed or shaken free of all adhering soil, but not scraped. Curing is best effected in a well-ventilated room heated to about 90° F. Nearly a month is required to cure the larger roots.

The average value of the exports of ginseng from the United States for the past 12 years is \$1,720,595.

Ginseng production is a minor industry which affords an opportunity for profit to only a limited number of judicious growers.

Contribution from the Bureau of Plant Industry

WM. A. TAYLOR, Chief

Washington, D. C.

April, 1921

GINSENG CULTURE¹

W. W. STOCKBERGER,

Physiologist in Charge of Drug, Poisonous, and Oil Plant Investigations.

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GINSENG is a native product of recognized importance. The export trade in dry roots has existed for more than a century and for the last 15 years attained an average annual value of over a million dollars.

The natural production of ginseng, diminished by overcollection and the contraction of suitable forest areas, has dwindled to such an extent that prices have risen to levels warranting cultivation, which has proved successful in judicious hands. The plant, however, has little domestic value except for the exploitation of amateur cultivators and depends on a distant oriental market (China) for its standing as a commodity. As a commercial product it would appear particularly liable to overproduction, which danger, however, is greatly lessened by the slow development of the plant and the inherent difficulties of its cultivation.

Under the present conditions of production ginseng offers attractive possibilities to patient cultivators who appreciate the limitations of growth and the slow development of woodland plants in general, and are willing to make a material outlay with only scanty returns in view for several years to come, but it holds out no inducement for inexperienced growers looking for quick profits from a small investment.

The culture of ginseng and of special crops generally is best begun in an inexpensive and experimental manner, enlarging the equip-

¹ Much of the information in this bulletin has been taken almost verbatim from Farmers' Bulletin 551, by Dr. Walter Van Fleet, issued in 1918.

ment only as reasonable success seems assured. "Plunging" in ginseng is as likely to prove disastrous as in other forms of business.

THE GINSENG PLANT.

American ginseng (fig. 1), botanically known as *Panax quinquefolium* of the family Araliaceæ, is a fleshy rooted herbaceous plant.

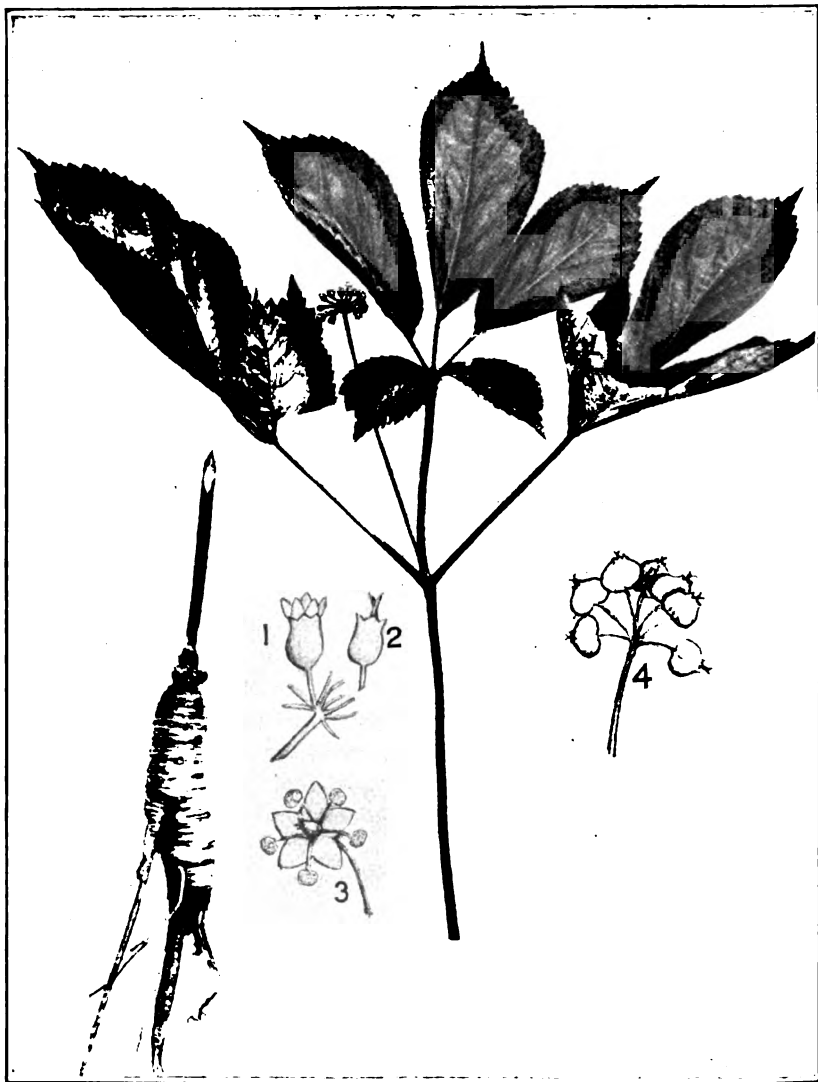


FIG. 1.—Branch, root, flower, and berries of American ginseng.

growing naturally on the slopes of ravines and in other shady but well-drained situations in hardwood forests, in varying abundance from Maine to Minnesota and southward in the mountain regions to

Georgia and the Carolinas. In its wild state it grows from 8 to 20 inches high, bearing three or more compound leaves, each consisting of five thin, stalked, ovate leaflets, pointed at the apex and rounded or narrowed at the base, the three upper leaflets being larger than the two lower ones. A cluster of from 6 to 20 small greenish yellow flowers is produced in midsummer, followed by as many bright-crimson berries, each containing from one to three flattish wrinkled seeds the size of small peas.

The root is thick, spindle shaped, 2 to 4 inches long, and $\frac{1}{2}$ to 1 inch or more in thickness, in the older specimens generally branched and prominently marked with circular wrinkles. Branched roots having some resemblance to the human form are said to be in particularly high favor in China.

The seeds (fig. 2) are slow in germination and should never be permitted to become dry. As soon as they are gathered they should be mixed with twice their bulk of moist sand, fine loam, old sawdust, or woods earth, and stored in a damp, cool place until they are planted. As a rule the seeds do not germinate until a year from the spring following their ripening, and this fact must be borne in mind in purchasing seed for planting.

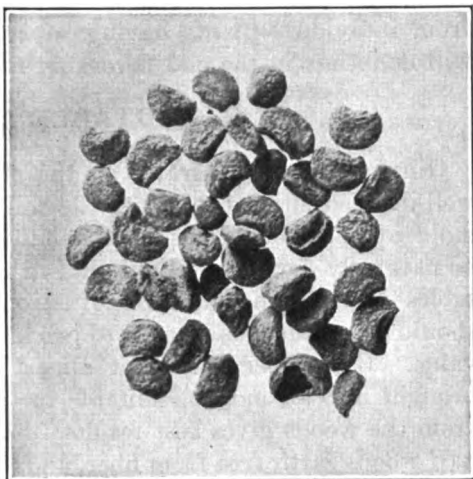


FIG. 2.—Seeds of American ginseng. (Natural size.)

Ginseng seedlings grow about 2 inches high the first year, with three leaflets at the apex of the stem. The second-year plants may reach a height of 5 or 6 inches, bearing two compound leaves, each composed of five characteristic leaflets. A third leaf is generally added the next year, when fruits may be expected. In succeeding years a fourth leaf is formed and the fruiting head reaches its maximum development, sometimes producing as many as 100 seeds, but the average under cultivation seldom exceeds 40 seeds to a plant.

VARIETIES.

There are various recognizable geographical races of American ginseng, not all of which are of the same value to the grower. Plants from the northern range, particularly those indigenous to New York and Wisconsin, appear to possess the most useful characteristics and

form the best basis for breeding stocks. Southern ginseng, though vigorous and forming roots of good size and shape, does not seed well in northern localities, evidently finding the season too brief. Some of the western types have long, thin roots of undesirable character, and another local form, dwarf in growth, has small, round, and almost worthless roots. The beginner should endeavor to procure from reliable dealers the best commercial types of ginseng as a foundation for his breeding stock.

The culture of native ginseng has been too brief to induce varietal changes, but liberal fertilization and continual selection of seeds from individual plants having superior commercial characteristics will doubtless in the end favorably modify the wild type of plants.

SUITABLE SOILS.

Ginseng grows naturally on the slopes of ravines and in other well-drained situations where the soil is formed from the acid leaf mold of hardwood forests. For cultivated ginseng the soil should be naturally dry, fairly light, and in a condition to grow good vegetables without the addition of strong manure. Very sandy soil should be avoided, as it tends to produce hard, flinty roots of inferior value. By proper treatment almost any fairly good soil can be brought into a condition suitable for ginseng. The addition of soil from the woods gives best results. For seed beds the soil should be half woods earth free from fiber, and, if inclined to be heavy, enough sand should be added so that the mixture will not bake or harden even after heavy rains.

GROWING THE CROP.

Before the diseases of ginseng became such a menace to the industry, practical growers advised the starting of ginseng plantings with both young roots and seeds. By planting roots 3 or more years old a moderate seed crop may be had the first year, and a stock of 1-year or 2-year roots set at the same time will start the rotation which is necessary to provide for a marketable crop of roots each year after the first crop is harvested. However, the grower who purchases roots for planting incurs the risk of introducing disease into his beds, and it appears to be the better policy not to take chances with roots but to depend entirely upon seeds.

Ginseng seeds are advertised for sale by many of the older growers and are usually procurable at prices varying from 50 cents to \$1.50 per thousand. Seeds are often sold by weight, and it is estimated that 1 pound of average seed should produce 7,000 to 8,000 plants. Stratified seeds usually cost more than fresh seeds, but are regarded

as far more satisfactory for beginners. As the output of seeds is likely to become greater than is necessary to extend the plantation, it is well to restrict seed production by nipping the flower heads unless a good market for the seeds is assured. Roots gain more rapidly in size and weight if the plants are not permitted to seed.

PLANTING.

Ginseng seeds are best planted in spring, as early as the soil can be worked to advantage. Only cracked or partially germinated seeds should be used. They may be planted 6 inches apart each way in the permanent beds or 2 by 6 inches in seed beds, and transplanted when 2 years old to stand 6 or 8 inches apart. The seeds should be covered 1 inch deep with woods soil or old rotten hickory or basswood sawdust; that from pine or oak trees should not be used. The roots may be set any time from October to April when the soil is in suitable condition, the crowns being placed about 2 inches below the surface. Fall planting, however, is usually preferred. The most approved distances to plant are 6 or 8 inches apart each way, the latter being preferred when roots are to be grown until 7 years old.

Many planters round the surface of the beds, making the center several inches higher than the sides, since they find space for more plants on the curved than on the flat surface; but others claim that the possible injury from drought in very convex beds more than offsets this advantage. It is important, however, to have the beds well built up with centers high enough not to retain water after a rain. The paths or alleys should be much lower than the beds, and if they incline from one end to the other they will serve as surface drains during heavy rains. For roots the beds should be worked fully 12 inches deep, but the seed beds need not be so deeply stirred, as it is not advisable to have them settle to any marked extent.

SHADING.

Ginseng grows naturally in rather dense shade, and under cultivation must be shielded from direct sunlight by the shade of trees or by some construction that will reduce the light to about one-fourth its normal intensity. This may be accomplished by planting it in forest beds or in cultivated ground by erecting sheds open to the north and possibly to the east, but covered at the top and the south and west with laths or boards so spaced as to cut out nearly three-fourths of the sunlight. Brush and heavy burlap have been used with fair success for shading, but thin or ordinary muslins do not intercept enough light. Denser shade is required in the South than in the North. The rule appears to be one-sixth sunlight in the latitude of Kentucky and somewhat less for the South, rising to one-

fourth or more in Michigan and Wisconsin. In the North, where open construction is preferred, Lima beans or morning-glories may be planted on the south and west sides and allowed to run on poultry netting, thus furnishing shade during the brightest summer months.

There are many methods of constructing shade, but the most common is to set posts firmly in the ground 8 feet apart each way and about 7 feet high above the ground. Scantlings 2 by 4 inches in size are nailed on top of the posts, running the long way of the shed. The shade is usually made in sections 4 by 8 feet long, using common 4-foot laths or slats nailed on strips 2 by 2 inches and 8 feet long. The laths should be spaced from one-fourth to one-half inch apart, according to locality, whether in the North or in the South. These sections of shading are laid on top of the 2 by 4 inch runners and so



FIG. 3.—Lath shed affording partial shade, well suited for growing gingseng, golden-seal, and other woodland plants.

nailed to the posts that the laths run about north and south, thus giving the plants below the benefit of constantly alternating light and shade. (Fig. 3.) Owing to the high cost of lumber, some growers advocate replacing the runners with No. 4 wire, which is run over the tops of the posts and securely fastened thereto.

In the construction of artificial shade it should be borne in mind that free ventilation is very necessary for ginseng. "The higher the shade the better," is a maxim worth following, and open sides at the north and east will further promote free circulation of the air.

For covering seed beds a rather low shade is desirable, to avoid the washing out of the seeds by the drip from the laths. Poultry netting covered with brush, straw, litter, or burlap, made light in spring and denser as the sun gains power, answers very well.

The beds under shade should be 4 feet wide and preferably should run east and west, being so placed that the drip will fall to a great extent in the paths. The sides may be of 12-inch boards set 8 inches or more in the ground to keep out moles and held in place with small stakes.

FERTILIZING.

Several weighty arguments may be offered against the excessive use of fertilizers. Heavy feeding tends to lessen the resemblance of the cultivated root to the wild product and consequently reduces its value, since the root most closely resembling the wild in appearance and texture is now in strongest demand. Overfeeding also forces growth and thereby renders the plant less resistant to the attacks of disease. Lime and wood ashes have been used by many growers on their ginseng beds, but either root rust or fiber rot has almost invariably followed their use. Serious leaf injury has frequently followed the excessive use of nitrogenous fertilizers, and heavy applications of barnyard manure have also caused severe injury. Experienced growers are now recommending a good rich soil to start with and very moderate forcing.

The very best fertilizers are woods soil or rotted leaves 4 to 6 inches deep, well spaded in to a depth of about 8 inches, and fine raw bone meal well worked in, applied at the rate of 1 pound to each square yard. If barnyard manures are used they should be very thoroughly rotted, and in order to give the best results they should be worked in some months previous to planting the beds. Chemical fertilizers and wood ashes have been used, but as very injurious results have sometimes followed it is best, for the beginner at least, to depend on rotted leaves and raw ground bone to enrich the soil.

CULTIVATING.

Ginseng requires little cultivation if any, but grass and weeds should be kept out of the beds, and the surface of the soil should be scratched with a light tool whenever it shows signs of caking. Ordinarily one active man can easily care for about 2 acres of ginseng.

MULCHING.

In accordance with natural conditions a winter mulch over the crowns is essential, especially in northern localities. Seedling beds particularly require careful mulching to prevent heaving by frost.

Forest leaves held in place with poultry netting or light brush are best, but cornstalks stripped of the husks, bean vines, cowpea hay, buckwheat straw, or other coarse litter not containing weed seeds or material attractive to mice, will answer the purpose. The mulch should not be placed in position until actual freezing weather is imminent, and should be removed in spring before the first shoots come through the soil.

A mulch of 4 or 5 inches of leaves or their equivalent in litter is ample for the severest climate, and less is needed in the South.

DRAINAGE.

In laying out ginseng beds provision must be made for efficient drainage. The preferable location is on ground which has a gentle slope, but as natural drainage can not be depended upon always to remove excess water from the beds some type of underground drain must be employed. Very satisfactory results have been obtained by the use of clay or cement draintile in ginseng beds.² A line of tiles should be placed under the center of each bed. The proper depth of the drain will vary with the character of the soil, and the size of the tiles will depend upon the amount of rainfall. In general, if 3-inch tiles are used the drains should be placed 6 to 8 feet apart and 1½ to 2 feet deep in clay and 3 to 4 feet deep in sand or gravel.

FOREST PLANTINGS.

The earlier successes with ginseng culture were made with forest plantings, and this method is still preferred by many growers when a suitable location is available. The beds should be placed where the shade is continuous and fairly dense. The shade should be produced by tall open-headed trees rather than by undergrowth, to insure free circulation of the air. Some experienced growers prefer to plant on land which slopes to the north, thereby providing good drainage, without which ginseng will not thrive, and the coolest location during the heat of summer. The soil should be deeply plowed or spaded and all tree roots removed. The growth of these roots into the beds should be prevented by occasionally cutting around them with a sharp spade. A liberal quantity of leaf mold or well-decayed litter should be worked into the soil, and an application of bone meal raked into the surface will in most cases be a desirable addition. Ginseng may be planted closer under forest conditions than in garden culture, but in either case the closer the plants stand the greater is the danger from disease. The culture of forest beds is in all respects similar to that of beds under artificial shade, and the winter mulch should in no case be omitted.

² For detailed information regarding tile drainage, see *Farmers' Bulletin 524*, entitled "Tile Drainage on the Farm."

PROTECTION.

Owing to the comparatively high cost of ginseng plants and roots, the beds should be well protected by secure fences from the intrusion of wild or domestic animals, and should also be securely guarded against theft, which is not uncommon with this high-priced product. Protection is especially needed with forest plantings, which should always be well inclosed. Moles may be controlled with suitable traps,* of which several kinds are on the market, or the beds may be guarded with boards or wire netting of sufficiently close mesh set 12 to 18 inches in the ground.

DIGGING AND DRYING THE ROOT.

The cured root is valued by the Chinese largely according to its size and maturity. The best qualities of proper age break with a somewhat soft and waxy fracture. Young and undersized roots dry hard and glassy and are regarded as less desirable. Very small roots and root fibers often realize less than a dollar a pound, while those of the proper size and quality sell readily at top quotations. Cultivated roots as a rule attain greater size than wild ones of the same age, but lack density of substance until well past the fifth year of development.

Beds should rarely be dug for market until the sixth year, and should then be taken up solidly and the undersized roots replanted or securely heeled in until time to plant in the spring. Good roots should run nearly 4 inches long, half an inch in thickness below the crown, and should average about an ounce in weight in the fresh state.

Roots may be dug at any time after growth ceases in September, but mid-October is regarded as the most favorable time. They should be carefully washed or shaken free of all adhering soil, but not scraped, as it is important to preserve the natural dusky color of the skin with its characteristic annular markings.

The older roots possess the most substance, and when properly cured realize the highest prices. It appears almost useless to offer for sale three-year or four-year roots, even if well grown and of good size, as buyers for the Chinese market have learned to discriminate against them.

Drying is best effected in a well-ventilated room heated by a stove or furnace. It has long been customary to start drying between 60° and 80° Fahrenheit, and after a few days to increase the temperature to about 90°, but some experienced growers now recommend that drying start between 100° and 110°, and as soon as the roots are wilted that the temperature be reduced to about 90° Fahrenheit.

* See Farmers' Bulletin 583, entitled "The Common Mole of Eastern United States."

The roots are spread thinly on lattice trays or shelves made of wire netting, and are frequently examined and turned, but must always be handled carefully to avoid breaking the forks or marring the surface. Roots measuring more than 2 inches in diameter will need to be dried for about 6 weeks, but smaller roots may be properly dried in less time. In all stages of curing, especially in noticeably damp weather, particular care should be taken to see that the root does not mold or sour, as any defect will greatly depress the selling price. On the other hand, overheating should be avoided, as it tends to discolor the surface and spoil the texture of the interior. Once well cured, the roots should be stored in a dry and airy place, secure from vermin, until ready for sale.

DISEASES.

Cultivated ginseng is frequently subject to severe attacks of a number of blights, wilts, and rots, the development of which appears to be especially favored by the crowding of the plants, excess of water in the soil, and lack of proper ventilation.

In their natural state the plants as a rule are thinly scattered on the forest floor under advantageous conditions of ventilation and soil drainage, the normal action of tree roots playing no inconsiderable part in the latter condition, and diseases, of which there are several, are likely to remain quite local in effect; but under the crowded conditions of commercial culture they tend to spread and may cause material injury. Errors in fertilization and soil treatment are also frequent causes of injury, and by weakening the resistance of the plants further invite the inroads of disease.

Farmers' Bulletin 736, entitled "Ginseng Diseases and Their Control," treats of the symptoms, cause, and control of the various diseases of the ginseng plant, and prospective growers especially will find much useful information in its pages.

YIELD AND VALUE OF THE CROP.

The yield of cultivated ginseng varies greatly and depends largely upon the suitability of the conditions under which the crop is grown and upon the skill and experience of the grower. It has been estimated that the roots from a bed measuring 4 by 16 feet, if dug when 6 years old, should weigh about 10 pounds when dry. Yields of dry root from well-managed plantings appear to be at the rate of a ton to the acre, although much larger yields are frequently reported.

Ginseng has long been valued by the Chinese for medicinal use, though rarely credited with curative virtues by the natives of other countries. The dried roots have been exported from this country in increasing quantities since the early years of the eighteenth century, the prices rising as the wild supply diminished from about 40 cents

a pound in the early years of its collection to more than \$20 a pound for the best qualities during the year 1919.

The cultivation of native ginseng, stimulated by its increasing scarcity and the rising prices, began in an experimental way about 1886 and for a time developed slowly. It is estimated that in 1901 a little less than 20 acres of ginseng were under cultivation in the United States, and of the root produced but a small quantity went into the market. In recent years the industry has attained such proportions that the output of cultivated roots appears to be considerably greater than that collected from the forests.

When cultivated ginseng first appeared on the market it sold at prices considerably higher than those paid for the wild root, but about 1904 the price declined to a figure less than that commanded by wild ginseng and since that time has continuously remained at a lower level. The preference in the Chinese markets for wild ginseng over the American cultivated root, which has greatly increased during recent years, is largely responsible for the constantly increasing difference in the prices offered for wild and cultivated ginseng in the markets of the United States.

A negligible quantity of ginseng root is consumed by Chinese residents of North America, and a trifle has been used by manufacturers of domestic medicine, leaving practically the sole outlet for their product with the Koreans and Asiatic Chinese. The domestic prices, exports, and valuation of American ginseng for the 20 years ended June 30, 1919, are shown in Table I.

TABLE I.—*Domestic prices, exports, and value of American ginseng from 1900 to 1919, inclusive.*

Year.	Domestic prices (per pound). ¹				Exports. ²		
	Wild root.		Cultivated root.		Pounds.	Total value.	Average value per pound.
	High.	Low.	High.	Low.			
1900.....	\$6.10	\$2.75	\$7.00	\$4.00	160,901	\$833,710	\$5.18
1901.....	8.75	3.75	10.00	5.75	149,069	801,672	5.38
1902.....	6.35	3.00	8.00	3.00	154,063	856,515	5.55
1903.....	7.50	4.00	7.50	5.25	151,985	796,008	5.23
1904.....	8.10	5.00	8.00	7.00	131,882	851,820	6.45
1905.....	7.50	6.00	.....	.....	146,576	1,069,849	7.29
1906.....	7.50	6.00	7.00	4.00	160,949	1,175,844	7.30
1907.....	7.00	5.00	6.25	3.00	117,696	813,023	6.90
1908.....	7.00	4.50	6.25	4.00	154,180	1,111,994	7.21
1909.....	8.00	5.40	7.25	5.00	186,257	1,270,179	6.82
1910.....	8.00	5.50	7.25	5.00	192,406	1,439,434	7.48
1911.....	7.50	5.00	7.00	5.00	153,999	1,088,202	7.06
1912.....	9.00	5.00	7.50	3.00	155,308	1,119,301	7.20
1913.....	10.00	6.00	6.50	3.00	221,901	1,665,731	7.50
1914.....	11.50	6.00	8.00	3.00	224,605	1,832,686	8.15
1915.....	9.50	4.50	7.00	2.00	103,184	919,931	8.91
1916.....	11.00	5.00	6.50	3.00	256,082	1,597,508	6.23
1917.....	14.00	6.00	7.00	2.50	198,480	1,386,203	6.98
1918.....	19.00	9.50	9.00	3.00	259,892	1,717,548	6.60
1919.....	23.00	13.00	12.50	3.00	282,043	2,057,260	7.29

¹ Prices for 1900 to 1906 were obtained from dealers in Cincinnati, Ohio; prices for 1907 to 1919 were compiled from Hunter-Trapper.

² From Annual Reports of Foreign Commerce and Navigation of the United States.

THE OUTLOOK FOR THE INDUSTRY.

The future success of cultivated ginseng in America will be determined to a great extent by the attitude of the growers. If the lessons taught by the experience of the preceding 20 years are heeded, the mistakes of the past need not be repeated, and many obstacles which have heretofore hampered the progress of the industry can be removed.

The industry still suffers from the disrepute into which it was brought through the exaggerated claims made by many dealers in seeds and nursery stock with regard to the possibilities for unusually large profits in the growing of ginseng. Although ginseng is a comparatively unimportant product in this country, it has a place among minor crops of recognized value. For every dollar's worth of ginseng exported in 1919 there were produced in this country about \$38 worth of peanuts, \$13 worth of onions, \$11 worth of hops, \$6 worth of strawberries, and \$1.30 worth of olives.

In comparison with other crops, the market outlet for ginseng is small; consequently, the industry affords an opportunity only for a limited number of persons without danger of its becoming overcrowded. Since yields of the dry root from well-managed plantings appear to be at the rate of a ton to the acre, about 100 acres of mature ginseng could very readily supply 204,780 pounds of root, which is the average exportation for the last 10 years. This would represent total plantings of nearly 700 acres, as it requires at least 6 years to grow marketable roots from seed.

The Chinese market formerly absorbed ginseng in quantities considerably in excess of the average exportations for the two decades just past. As shown in Table II, the number of pounds exported during the last 10 years is less than half of the exports for the 10 years 1860-1869, inclusive, while the average price per pound for the 10 years 1910-1919, inclusive, is nearly eight times greater than it was some 60 years ago. Since the exports of ginseng appear to be increasing in volume, notwithstanding the relatively high prices now paid for the root, a continuance of the demand for the American product may be reasonably expected.

TABLE II.—*Exports and value of American ginseng by decades, 1860 to 1919, inclusive.*

Exports for the 10 years.	Pounds.	Value.	Average value per pound.
1860 to 1869	4, 149, 445	\$3, 902, 209	\$0.94
1870 to 1879	4, 041, 727	4, 537, 008	1.12
1880 to 1889	3, 457, 294	6, 771, 830	1.95
1890 to 1899	2, 163, 302	7, 843, 888	3.62
1900 to 1909	1, 513, 558	9, 610, 614	6.34
1910 to 1919	2, 047, 800	14, 823, 781	7.24

The evident preference of the Chinese for the wild root and the unsatisfactory state of the general market for cultivated ginseng have caused grave doubts as to the future prospects of the industry. These doubts will probably be realized unless growers give more attention to the production of the type of root desired by the Chinese trade. In the future, growers should strive for quality of product and not for quantity of production, as has been the all too common practice in the past. There is always a ready sale for the cultivated roots which closely resemble the wild in quality and condition, and prudent growers will not fail to adopt the wild root as the standard of future production. The elimination of the poorer grades of cultivated American ginseng which are now found in the markets would tend to insure more uniform prices for the root and to lessen the danger of depressing the market through overproduction.

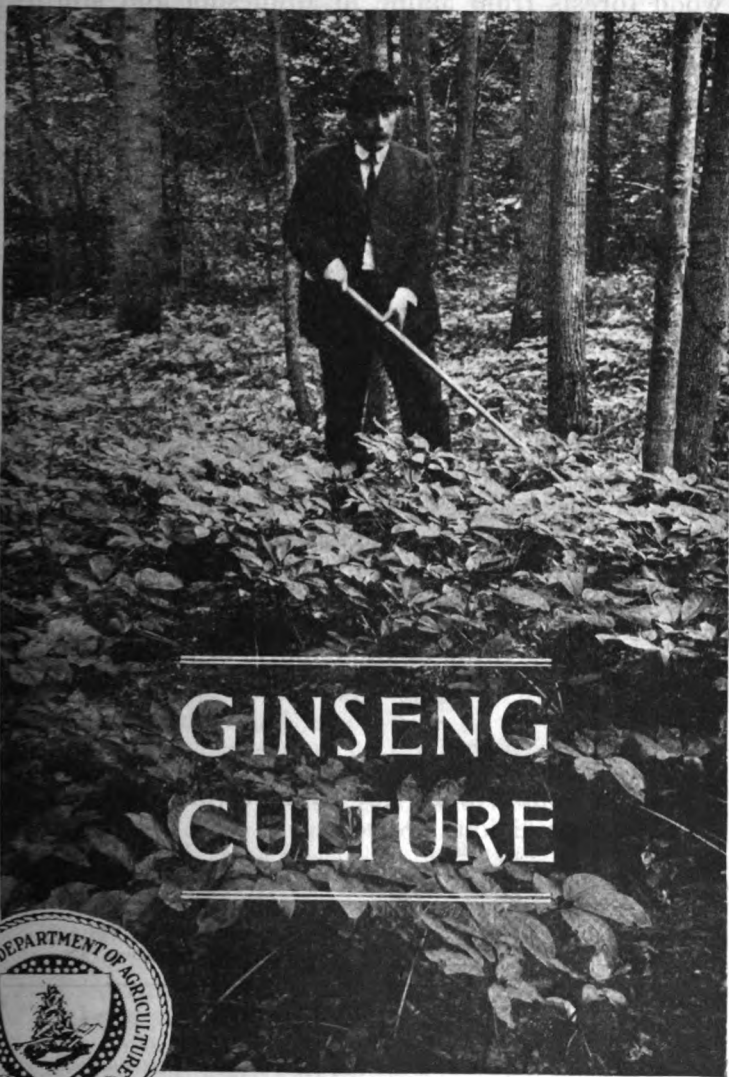


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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1184

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GINSENG CULTURE



GINSENG is a fleshy-rooted herbaceous plant native to this country and formerly of frequent occurrence in shady, well-drained situations in hardwood forests from Maine to Minnesota and southward in the mountain regions to Georgia and the Carolinas.

When placed under culture ginseng should be shielded from direct sunlight by the shade of trees or by lath sheds. The soil should be fairly light and well fertilized with woods earth, rotted leaves, or fine raw bone meal. Seed should be planted in the spring, as early as the soil can be worked. Only cracked or partially germinated seed should be used. Ginseng needs little cultivation, but the beds should at all times be kept free from weeds and grass. A winter mulch over the crowns is usually essential.

The roots do not reach marketable size until about the sixth year from seed. When dug they should be carefully washed or shaken free from all adhering soil, but not scraped. Curing is best effected in a well-ventilated room heated to about 90° F. About a month is required to cure the larger roots.

The average value of the exports of ginseng from the United States for the last 10 years was more than \$2,000,000.

Ginseng production is a minor industry which affords an opportunity for profit to only a limited number of judicious growers.

Washington, D. C.

Issued April, 1921
Revised October, 1928

GINSENG CULTURE¹

By W. W. STOCKBERGER, *Principal Physiologist in Charge of Office of Drug, Poisonous, and Oil Plants, Bureau of Plant Industry*

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INTRODUCTION

GINSENG is a native product of recognized importance. The export trade in dry roots has existed for more than a century and for the last 10 years attained an average value of more than \$2,000,000.

The natural production of ginseng, diminished by overcollection and the contraction of suitable forest areas, has dwindled to such an extent that prices have risen to levels warranting cultivation, which has proved successful in judicious hands. The plant, however, has little domestic value except for the exploitation of amateur cultivators and depends on a distant oriental market (China) for its standing as a commodity. As a commercial product it would appear particularly liable to overproduction, which danger, however, is greatly lessened by the slow development of the plant and the inherent difficulties of its cultivation.

Under the present conditions of production ginseng offers attractive possibilities to patient cultivators who appreciate the limitations of growth and the slow development of woodland plants in general and are willing to make a material outlay with only scanty returns in view for several years to come, but it holds out no inducement for inexperienced growers looking for quick profits from a small investment.

The culture of ginseng and of special crops generally is best begun in an inexpensive and experimental manner, enlarging the equipment only as reasonable success seems assured. "Plunging" in ginseng is likely to prove disastrous as in other forms of business.

¹ In this revision the writer has made free use of the helpful criticisms and suggestions received from a number of successful growers of ginseng.

THE GINSENG PLANT

American ginseng (fig. 1), botanically known as *Panax quinquefolium* of the family Araliaceae, is a fleshy-rooted herbaceous plant, growing naturally on the slopes of ravines and in other shady but well-drained situations in hardwood forests, in varying abundance

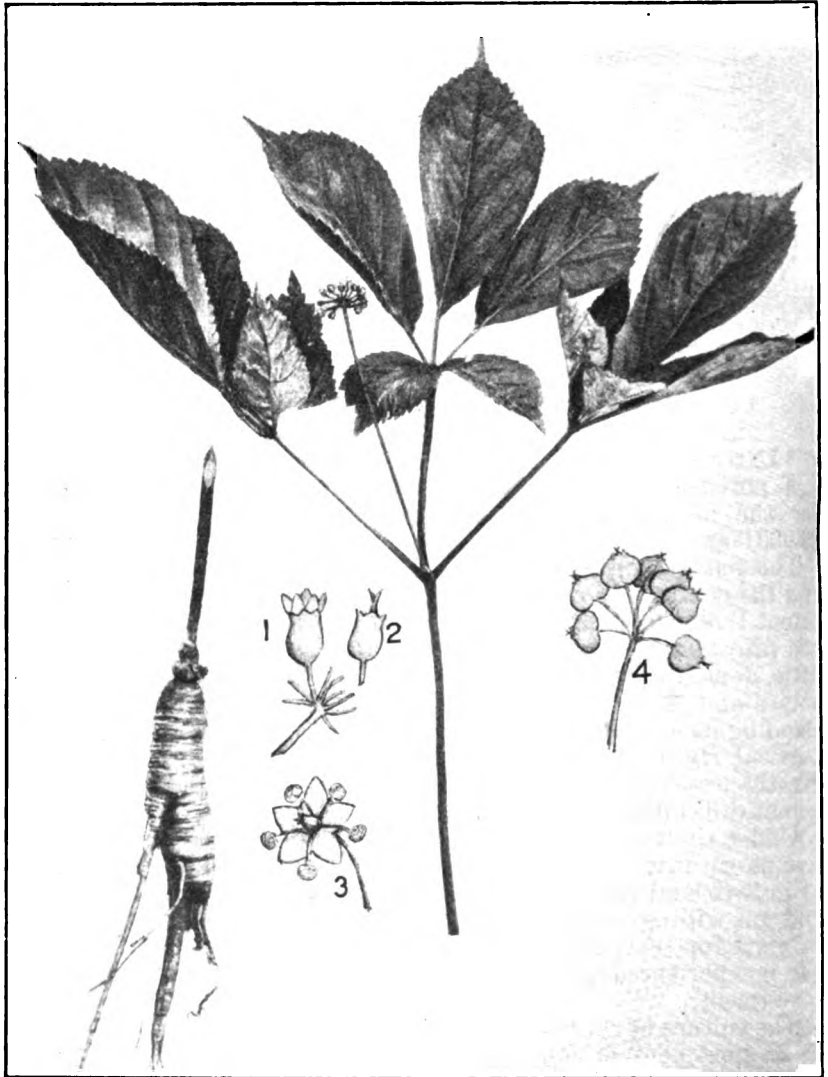


FIG. 1.—Branch, root, flower, and berries of American ginseng

from Maine to Minnesota and southward in the mountain regions to Georgia and the Carolinas. In its wild state it grows from 8 to 20 inches high, bearing three or more compound leaves, each consisting of five thin, stalked, ovate leaflets, pointed at the apex and rounded

or narrowed at the base, the three upper leaflets being larger than the two lower ones. A cluster of from 6 to 20 small greenish yellow flowers is produced in midsummer, followed by as many bright crimson berries, each containing from one to three flattish wrinkled seeds the size of small peas. The berries of northern ginseng rarely contain three seeds, but in southern ginseng berries containing three seeds are very common.

The root is thick, spindle shaped, 2 to 4 inches long, and one-half to 1 inch or more in thickness, in the older specimens generally branched and prominently marked with circular wrinkles. Branched roots of the wild Manchurian and Korean ginseng having some resemblance to the human form are said to be in particularly high favor in China, but this feature gives no special value to American ginseng.

The seeds (fig. 2) are slow in germination and should never be permitted to become dry. As soon as they are gathered they should be mixed with twice their bulk of moist sand, fine loam, sawdust, or woods earth, and stored in a damp, cool place until they are planted. As a rule the seeds do not germinate until a year from the spring following their ripening, and this fact must be borne in mind in purchasing seed for planting.



FIG. 2.—Seeds of American ginseng. (Natural size)

Ginseng seedlings grow about 2 inches high the first year, with three leaflets at the apex of the stem. The second-year plants may reach a height of 5 or 6 inches, bearing two compound leaves, each composed of five characteristic leaflets. A third leaf is generally added the next year, when fruits may be expected. In succeeding years a fourth leaf is formed and the fruiting head reaches its maximum development. A single plant of southern ginseng sometimes produces as many as 300 seeds, but northern ginseng very rarely produces more than 100 seeds to the plant and the average under cultivation seldom exceeds 40.

VARIETIES

There are various recognizable geographical races of American ginseng, not all of which are of the same value to the grower. Plants from the northern range, particularly those indigenous to New York and Wisconsin, appear to possess the most useful characteristics and form the best basis for breeding stocks. Southern ginseng, though vigorous and forming roots of good size and shape, does not seed well at first in northern localities, but after a few years it becomes adapted to the climate and will mature seeds before

able character, and another local form, dwarf in growth, has small, round, and almost worthless roots. The beginner should endeavor to procure from reliable dealers the best commercial types of ginseng as a foundation for his breeding stock.

The culture of native ginseng has been too brief to induce varietal changes, but liberal fertilization and continual selection of seeds from individual plants having superior commercial characteristics will doubtless in the end favorably modify the wild type of plants.

SUITABLE SOILS

Soil and location are very important in the culture of ginseng, as it is a plant that grows naturally on the slopes of ravines and in other well-drained situations where the soil is formed from the acid leafmold of hardwood forests. The soil should be naturally dry, fairly light, and in a condition to grow good vegetables without the addition of strong manure. An absolutely new soil with the best of natural drainage is to be preferred. Very sandy soil should be avoided, as it tends to produce hard, flinty roots of inferior value. Although almost any fairly good soil can be brought into a condition suitable for ginseng by proper treatment, the cost of satisfactory sterilization is usually heavy. In numerous cases the addition of leafmold from hardwoods has given best results, since ginseng requires an acid soil. For seedbeds the soil should be half woods earth free from fiber, and, if it is inclined to be heavy, enough sand should be added so that the mixture will not bake or harden even after heavy rains.

GROWING THE CROP

Before the diseases of ginseng became such a menace to the industry, practical growers advised the starting of ginseng plantings with both young roots and seeds. By planting roots 3 or more years old a moderate seed crop may be had the first year, and a stock of 1-year or 2-year roots set at the same time will start the rotation which is necessary to provide for a marketable crop of roots each year after the first crop is harvested. However, the grower who purchases roots for planting incurs the risk of introducing diseases into his bed, and it appears to be the better policy not to take chances with roots but to depend entirely upon seeds.

Ginseng seeds are advertised for sale by many of the older growers and are usually procurable at prices varying from 50 cents to \$1.50 per thousand. Seeds are often sold by weight, and it is estimated that 1 pound of average northern seed should produce 7,000 to 8,000 plants, and 1 pound of average southern seed 10,000 plants or more. Stratified seeds usually cost more than fresh seeds, but are regarded as far more satisfactory. Dealers almost invariably supply seed that is at least a year old unless new seed is specially requested. As the output of seeds is likely to become greater than is necessary to extend the plantation, it is well to restrict seed production by nipping the flower heads unless a good market for the seeds is assured. Roots gain more rapidly in size and weight if the plants are not permitted to seed.

PLANTING

Except in the far Northwest it is best to plant ginseng seeds in the fall. If they are held until spring, growth may start before they can be planted, in which case many may be lost. Only cracked or germinated seeds should be used. They should be planted 8 inches apart each way in the permanent beds, or 2 by 6 inches in seedbeds and the plants transplanted when 2 years old to stand 8 inches apart. The seeds should be covered 1 inch deep with woods soil or old rotten hickory or basswood sawdust; that from pine or oak trees should not be used. The roots may be set in October or later in the fall so long as the soil is in suitable condition, the crowns being placed about 2 inches below the surface. The most approved distance to plant is 8 inches apart each way, when roots are to be grown until 7 years old in permanent locations.

Many planters round the surface of the beds, making the center several inches higher than the sides, since they find space for more plants on the curved than on the flat surface; but others claim that the possible injury from drought in very convex beds more than offsets this advantage. It is important, however, to have the beds well built up with centers high enough not to retain water after a rain. The paths or alleys should be much lower than the beds, and if they decline from one end to the other they will serve as surface drains during heavy rains. For roots the beds should be worked not more than 6 to 8 inches deep if on ordinary soil. Very heavy soils may be worked more deeply if necessary to obtain better drainage. Seedbeds need not be deeply stirred, as it is not advisable to have them settle to any marked extent.

SHADING

Ginseng grows naturally in rather dense shade, and under cultivation it must be shielded from direct sunlight by some construction that will reduce the light to about one-fourth its normal intensity. When it is planted in open ground this may be accomplished by erecting sheds open on all sides, but covered at the top with lath or boards so spaced as to cut out nearly three-fourths of the sunlight. It is not advisable to use burlap or muslin for shading, as these materials interfere with the free circulation of the air.

There are many methods of constructing shade, but the most common is to set posts firmly in the ground 8 feet apart each way and about 8 feet high above the ground. Scantlings 2 by 4 inches in size are nailed on top of the posts so as to run the long way of the shed. The shade is usually made in sections 4 by 8 feet long, using common 4-foot laths or slats nailed on strips 2 by 2 inches and 8 feet long. The laths should be spaced from one-fourth to one-half inch apart, according to locality, whether in the North or in the South. These sections of shading are laid on top of the 2-by-4 inch runners and so nailed to the posts that the laths run about north and south, thus giving the plants below the benefit of constantly alternating light and shade (fig. 3). Owing to the high cost of lumber, some growers advocate replacing the runners with No. 4 wire, which is run over the tops of the posts and securely fastened thereto.

In the construction of artificial shade it should be borne in mind that free ventilation is very necessary for ginseng. "The higher the

shade the better" is a maxim worth following, as gardens with a free circulation of air are apparently less likely to become diseased.

Seedbeds made under the regulation garden shade are often further protected by a rather low shade to avoid the washing out of the seeds by the drip from the laths. Poultry netting covered with brush, straw, litter, or burlap, made light in spring and denser as the sun gains power, answers very well. In seedbeds made in the open and protected by a low shade alone the seedlings are very apt to damp-off in warm wet weather.

The beds for permanent planting under shade should be 4 feet wide and preferably should run east and west, being so placed that



FIGURE 3.—Lath shed affording partial shade, well suited for growing ginseng, goldenseal, and other woodland plants.

the drip will fall to a great extent in the paths. The sides may be of 12-inch boards set 8 inches or more in the ground to keep out moles and held in place with small stakes.

FERTILIZING

Several weighty arguments may be offered against the excessive use of fertilizers. Heavy feeding tends to lessen the resemblance of the cultivated root to the wild product and consequently reduces its value, as the root most closely resembling the wild in appearance and texture is now in strongest demand. Overfeeding also forces growth and thereby renders the plant less resistant to the attacks of disease. Lime and wood ashes have been used by many growers on their ginseng beds, but either root rust or fiber rot has almost invariably followed their use. If lime is used at all it is well to apply it at least a year before planting. Serious leaf injury has

followed the excessive use of nitrogenous fertilizers, and heavy applications of barnyard manure have also caused severe injury. Experienced growers are now recommending a good rich soil to start with and very moderate forcing.

The very best fertilizers are woods soil or rotted leaves 4 to 6 inches deep, well spaded in to a depth of about 8 inches, and fine raw bonemeal well worked in, applied at the rate of 1 pound to each square yard. If barnyard manures are used they should be very thoroughly rotted, and in order to give the best results they should be worked in some months previous to planting the beds. Some practical growers advise against the use of animal manures or even a soil to which they have been heavily applied. Chemical fertilizers and wood ashes have been used, but as very injurious results have sometimes followed, it is best, for the beginner at least, to depend on hardwood leafmold, old rotted hardwood sawdust, and raw ground bone to enrich the soil.

CULTIVATING

Ginseng requires little if any cultivation, but grass and weeds should be kept out of the beds, and the surface of the soil should be scratched with a light tool whenever it shows signs of caking. Ordinarily one active man can easily care for about 2 acres of ginseng.

MULCHING

In accordance with natural conditions, a winter mulch over the crowns is essential, especially in northern localities. Seedling beds particularly require careful mulching to prevent heaving by frost.

Forest leaves held in place with poultry netting, light brush, or sawdust are best, but cornstalks stripped of the husks, bean vines, cowpea hay, buckwheat straw, or other coarse litter not containing weed seeds or material attractive to mice will answer the purpose. The mulch should not be placed in position until actual freezing weather is imminent, and it should be removed in the spring before the first shoots come through the soil.

A mulch of 4 or 5 inches of leaves or their equivalent in litter is ample for the severest climate, and less is needed in the South. A light summer mulch of sawdust helps keep down weeds and prevents excessive loss of moisture in dry weather.

DRAINAGE

In laying out ginseng beds provision must be made for efficient drainage. The preferable location is on ground that has a gentle slope, but as natural drainage cannot be depended on always to remove excess water from beds, some type of underground drain must be employed. Very satisfactory results have been obtained by the use of clay or cement drain tile in ginseng beds. A line of tiles should be placed under the center of each bed. The proper depth of the drain will vary with the character of the soil, and the size of the tiles will depend on the amount of rainfall. In general, if 3-inch tiles are used the drains should be placed 6 to 8 feet apart and 1½ to 2 feet deep in clay and 3 to 4 feet deep in sand or gravel.

FOREST PLANTINGS

The earlier successes with ginseng culture were made with plantings in hardwood forests, and this method is still preferred by many growers when a suitable location is available. However, the yield from forest plantings is said to be about one-half that obtained under artificial shade, but on the other hand there is a large saving in the expense for labor and the cost of shading. Growers on the Pacific coast have found that ginseng cannot be grown successfully under tree shade in that region.

In forest plantings the beds should be placed where the shade is continuous and fairly dense. The shade should be produced by tall, open-headed, hardwood trees rather than by undergrowth, to insure free circulation of air. Some experienced growers prefer to plant on land that slopes to the north, thereby providing good drainage, without which ginseng will not thrive, and the coolest location during the heat of the summer. The soil should be deeply plowed or spaded and all tree roots removed. The growth of these roots into the beds should be prevented by occasionally cutting around them with a sharp spade. A liberal quantity of leafmold or well-decayed litter should be worked into the soil, and an application of bonemeal raked into the surface will in most cases be a desirable addition. Ginseng may be planted closer under forest conditions than in garden culture, but in either case the closer the plants stand the greater is the danger from disease. The culture of forest beds is in all respects similar to that of beds under artificial shade, and the winter mulch should in no case be omitted.

PROTECTION

Owing to the comparatively high cost of ginseng plants and roots, the beds should be well protected by fences from the intrusion of wild or domestic animals and should also be carefully guarded against theft, which is not uncommon with this high-priced product. Protection is especially needed with forest plantings, which should always be well enclosed. Moles may be controlled with suitable traps,² of which several kinds are on the market. Mice often cause great damage to ginseng, but they may be kept from the beds by wire netting of sufficiently close mesh set 12 to 18 inches in the ground.

DIGGING AND DRYING THE ROOT

The cured root is valued by the Chinese largely according to its size and maturity. The best qualities at proper age break with a somewhat soft and waxy fracture. Young roots dry hard and glassy and are regarded as less desirable. Very small young roots and root fibers often realize less than a dollar a pound, whereas those of the proper size and quality sell readily at top quotations. Undersized or stunted roots if of suitable age are readily salable. Cultivated roots as a rule attain greater size than wild ones of the same age, but on account of their more rapid growth they are harder and denser than the wild roots, and if harvested before they are about 5 years old they will lack in flavor and quality.

Beds should rarely be dug for market until about the sixth year and should then be taken up solidly. The replanting of the under-

² See U. S. Department of Agriculture Farmers' Bulletin 1716, Mole Control.

sized or stunted roots is of doubtful value, since they frequently make little more growth. Good roots should run nearly 4 inches long and half an inch in thickness below the crown and should average about an ounce in weight in the fresh state.

Roots may be dug at any time after growth ceases in September, but mid-October is regarded as the most favorable time. They should be carefully washed or shaken free of all adhering soil, but not scraped or scrubbed, as it is important to preserve the natural dusky color of the skin with its characteristic annular markings.

The older roots possess the most substance and when properly cured realize the highest prices. In recent years a demand for ground ginseng has established a market for young roots, which are preferred for milling on account of their hard, flinty texture.

Drying is best effected in a well-ventilated room heated by a stove or a furnace. It has long been customary to start drying between 60° and 80° F. and after a few days to increase the temperature to about 90°, but some experienced growers now recommend that drying start between 100° and 110° and as soon as the roots are wilted that the temperature be reduced to about 90°.

The roots are spread thinly on lattice trays or shelves made of wire netting and are frequently examined and turned, but must always be handled carefully to avoid breaking the forks or marring the surface. Roots measuring more than 2 inches in diameter will need to be dried for about 6 weeks, but smaller roots may be properly dried in less time. In all stages of curing, especially in noticeably damp weather, particular care should be taken to see that the root does not mold or sour, as any defect will greatly depress the selling price. On the other hand, overheating should be avoided, as it tends to discolor the surface and spoil the texture of the interior. Once well cured, the roots should be stored in a dry and airy place, secure from vermin, until ready for sale.

DISEASES³

Cultivated ginseng is frequently subject to severe attacks of a number of diseases, the development of which appears to be especially favored by crowding of the plants, excess water in the soil, and lack of proper ventilation.

In their natural state the plants as a rule are thinly scattered on the forest floor under advantageous conditions of ventilation and soil drainage, the normal action of tree roots playing no inconsiderable part in the latter condition, and diseases are likely to remain local in effect. Under the crowded conditions of commercial culture, however, the diseases tend to spread and may cause material injury. Errors in fertilization and soil treatment are also frequent causes of injury and by weakening the resistance of the plants may further invite the inroads of disease.

ALTERNARIA BLIGHT AND ROOT ROT⁴

Alternaria blight is one of the most widespread ginseng diseases and affects both leaves and roots. During the spring the stems of diseased

³ Condensation of Farmers' Bulletin 736, Ginseng Diseases and Their Control, prepared by S. P. Doolittle, senior pathologist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry.

⁴ *Alternaria panax* Whetzel.

plants show dark-brown cankers just above the ground line, which enlarge and become covered with a velvety brown coating of the spores (microscopic seedlike bodies) of the fungus causing the disease. Later in the season, large, watersoaked spots develop on the leaves and eventually become papery and dry with a darker, yellow-brown margin (fig. 4).

Later the leaflets may droop where the leafstalk rises at the top of the stem, and brown spore masses may form again at this point. Seed heads are affected, and when such infection occurs the berries often shell. When roots are attacked they rot very slowly, and there is no odor. The lesions are dark brown or black, and the rotted roots

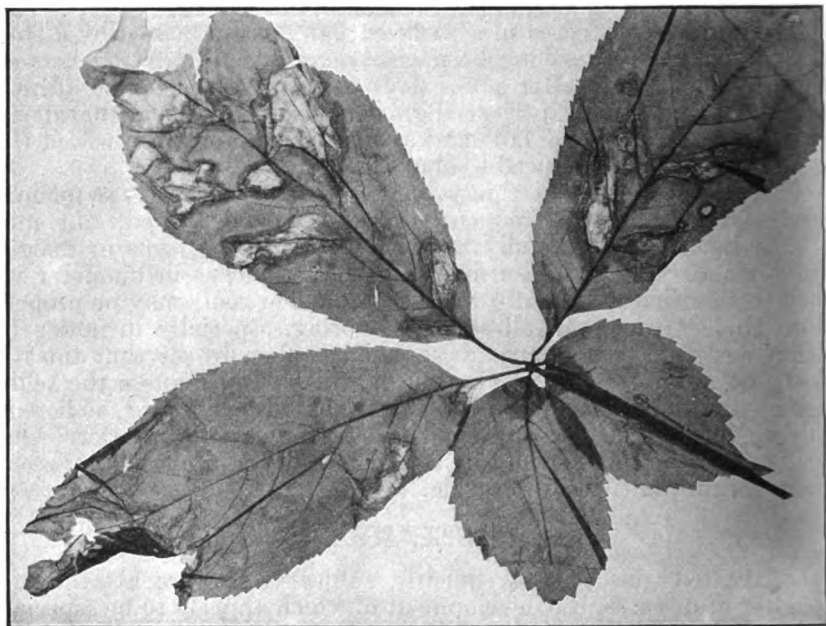


FIGURE 4.—Leaves of ginseng affected with alternaria blight.

remain firm. Root infection apparently occurs only in roots that have been injured.

The spores of the fungus are distributed by the wind and may be carried on clothing from diseased to healthy beds. During moist weather the spores that have lodged on the plants germinate and produce further infection. Because the fungus also lives over winter on diseased leaves and stems of the previous season, it is important that diseased tops be removed and destroyed. After the tops die down the beds also should be disinfected by being soaked down to a depth of an inch with a solution of 1 pound of copper sulfate to 7 gallons of water. The most effective means of control, however, consists in spraying the plants during the growing season with a 3-3-50 bordeaux mixture to which 2 pounds of calcium arsenate have been added (fig. 5). The first application should be made when the

majority of the plants have broken through the soil, the second when the leaflets are fully spread, the third just before blossoming, and the fourth after the fruits are set.

Bordeaux mixture can be purchased in paste and powder form and such preparations are often convenient for use in small plantings. It is somewhat more effective when freshly prepared, however, and can be made more cheaply at home by the following formula: Dissolve 3 pounds of copper sulfate in hot water, using a wooden or earthenware vessel, and dilute to 25 gallons with water. Slake 3 pounds of stone lime (or 5 pounds of hydrated lime) in a small amount of water and dilute to 25 gallons. Pour the two solutions together while stirring and add 2 pounds of calcium arsenate. When only small quantities of the spray are needed, it may be prepared by using 3 ounces of copper

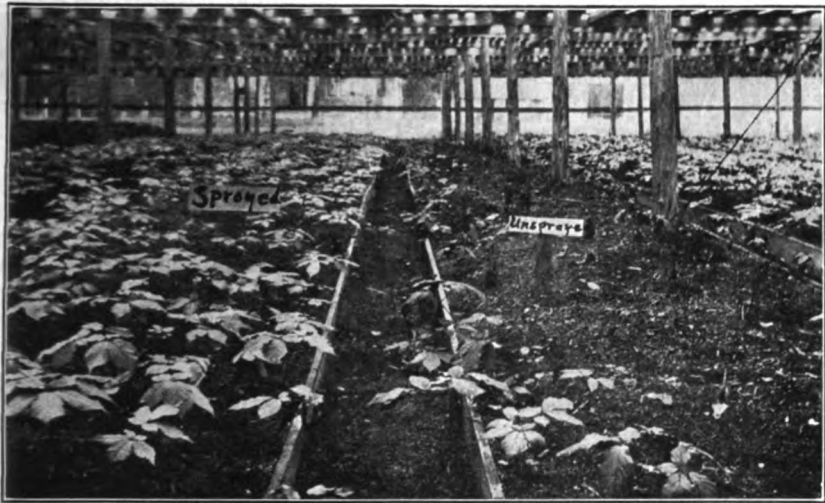


FIGURE 5.—Sprayed and unsprayed ginseng plants attacked by alternaria blight. Except that one was sprayed, both beds received the same treatment.

sulfate and 3 ounces of stone lime or 5 ounces of hydrated lime to a total of 3 gallons of water and adding 2 ounces of calcium arsenate.

PHYTOPHTHORA MILDEW AND ROOT ROT ⁵

Phytophthora mildew and soft rot is a fungus disease that affects leaves, stems, and roots of plants of all ages and frequently is very destructive. The leaflets at the top of the diseased plants often droop at the base of the petiole in much the same manner as in alternaria blight and the stems become hollow and discolored. The leaf blades also show spots that in their earlier stages resemble those of alternaria but, although the centers become white, the margins remain a dark, water-soaked green and do not show the yellow-brown border characteristic of alternaria spots (fig. 6). Infected roots develop a soft rot and eventually are invaded by other fungi and bacteria which produce a disagreeable odor.

⁵ *Phytophthora cactorum* (Cohn. and Leb.) Schröter

This fungus overwinters in the tissues of diseased plants in the soil and spring infection occurs either in roots or stem, but in either case both roots and tops eventually may become diseased.

The most effective control for the disease consists in spraying with bordeaux mixture as for alternaria blight. To prevent the fungus from passing down the stem to the roots, all wilting or drooping tops should be cut off at the crown and removed. Affected roots should

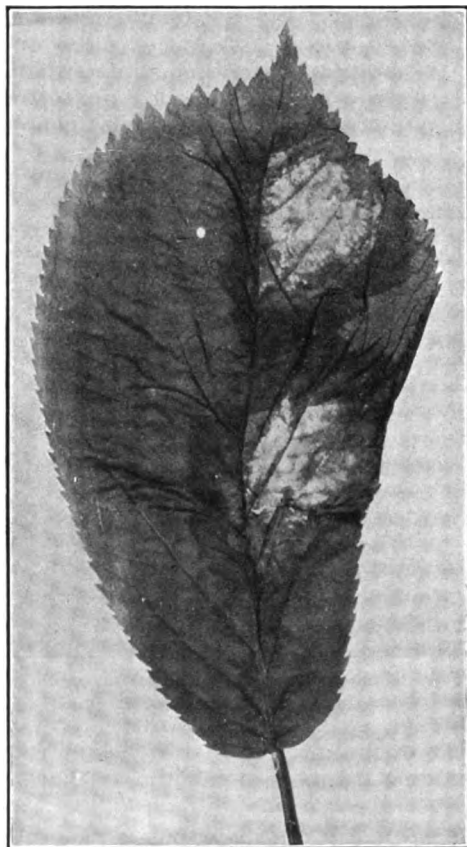


FIGURE 6.—Leaf-spot of phytophthora mildew on ginseng.

also be removed and destroyed, and the bed disinfected with a solution of 1 pound of copper sulfate in 7 gallons of water. Beds that are infested with this fungus should not be used for a number of years, but if for any reason infested beds must be used, they should be sterilized with steam⁶ or with a solution of 1 part of formaldehyde to 50 gallons of water. In using formaldehyde, all roots are first removed and the ground loosely spaded. The solution is then applied at the rate of $\frac{1}{2}$ to 1 gallon per square foot in sufficient quantity to thoroughly saturate the soil. As soon as it can be worked, the soil should then be spaded over to allow the formaldehyde to evaporate. This stirring of the soil should be repeated at intervals for at least 2 weeks before any planting is done, as formaldehyde fumes are injurious to growing plants.

ACROSTALAGMUS WILT⁷

Acrostalagmus wilt is a disease of older plants and rarely causes severe damage. It is

RAMULARIA ROOT ROT⁸

Ramularia root rot or "rust" is due to a fungus that may attack the roots of plants of all ages but is commonest on seedlings, which often

⁶ See Farmers' Bulletin 1629, Steam Sterilization of Soil for Tobacco and Other Crops.

⁷ *Acrostalagmus* sp.
ramularia sp.

are rendered worthless. On older roots the spots are a rusty brown but do not penetrate deeply. In seedlings the fine rootlets are damaged and the taproot may become short and knoblike. The disease is favored by an alkaline soil and where it occurs the use of lime or wood ashes should be avoided.

SCLEROTINIA ROTS

There are two ginseng diseases caused by fungi of the genus *Sclerotinia*. One, sclerotinia white rot,⁹ occurs in most sections where ginseng is grown but rarely causes widespread damage. It also affects many vegetable crops, and this probably explains its presence in beds on soil where such crops have previously been grown. The disease affects the roots and stem but does not spot the foliage. The diseased stems lose their green color and become hollow. Infected roots rot rapidly, and the tissues are soft and brittle but without bad odor. Within the stem and on the outside of the root, hard, black bodies are formed, sometimes one-quarter of an inch long, which are known as sclerotia. These are the resting bodies of the fungus and remain in the soil over winter. In the spring they produce small cuplike bodies containing spores, which serve as sources of new infection. Good drainage and aeration will do much to prevent losses from the disease. Infected plants should be removed and burned and the soil from which they came disinfected with a copper sulfate solution as described for phytophthora mildew (p. 12).

The other disease of this group, sclerotinia black rot,¹⁰ probably occurs on wild ginseng and also affects the plant known as false solomonseal.¹¹ It is probably often introduced through forest soil used in making up ginseng beds. It attacks only the roots, making little progress during the growing season. Its presence is indicated by failure of certain plants to come up in the spring, and on digging only black, mummylike roots will be found. Sclerotia are formed on these roots as in the case of white rot, and all roots in the diseased area should be removed and the soil disinfected as previously described (p. 12).

DAMPING-OFF OF SEEDLINGS

Damping-off of seedlings is characterized by a decay of the stem at the surface of the soil, which results in a falling over and death of the affected plants. The disease may be caused by a number of fungi which are commonly present in the soil and whose attacks are favored by excessive moisture and lack of aeration. Good drainage is therefore essential in raising seedlings. Sprinkling sand on the surface of the bed to a depth of one-eighth to one-fourth of an inch is also sometimes of value in checking damping-off. When planted in drills the soil should be kept stirred, particularly after rains. If seedbeds can be sterilized with formaldehyde (p. 12) before planting, losses from damping-off usually can be greatly reduced. Red oxide of copper has recently been widely used to control damping-off of vegetable seedlings. It is applied as a dust and the seed is shaken in a closed container with sufficient dust to thoroughly coat the seed. The excess dust is then screened off and the seed planted. The information available, how-

⁹ *Sclerotinia sclerotiorum* (Lib.) Massee.

¹⁰ *Sclerotinia smilacina* Dur. = *S. panacis* Rankin.

¹¹ *Smilacina racemosa* (L.) Desf.

ever, does not warrant a statement as to its effect on ginseng seed and, if it is used, a small sample of seed should first be dusted and tested to determine whether the treatment affects seed germination.

ROOT KNOT¹²

Root knot, a serious disease affecting nearly 1,500 different plants, is found on ginseng roots in many regions. It is caused by a nematode or eelworm,¹³ that lives in galls on the underground parts of the plants (fig. 7). Galls start as very slight swellings but may reach a diameter of one-half inch or more. By careful examination the shiny, white,

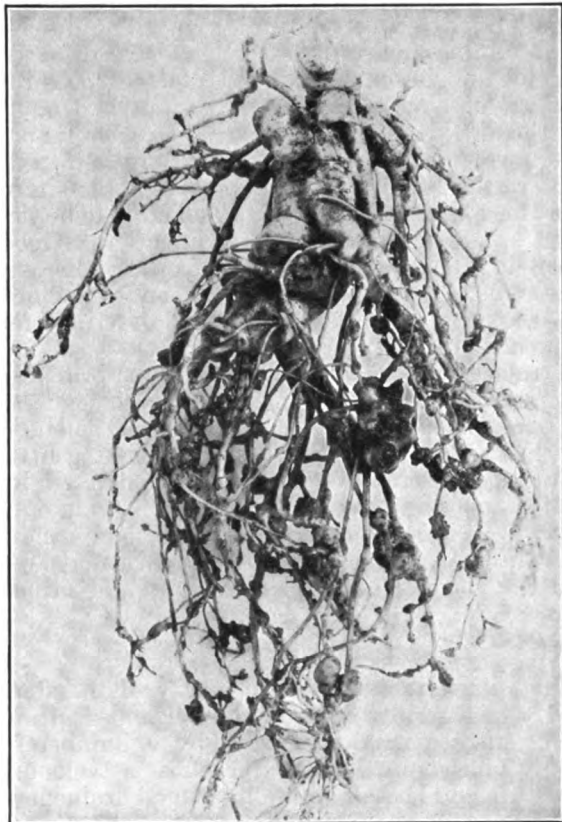


FIGURE 7.—Ginseng roots showing nematode galls.

pear-shaped female nematodes, usually much smaller than a pinhead, can be found in the galls with the unaided eye. This disease destroys ginseng seedlings; it reduces the market value of mature roots, and also makes them unfit for propagation.

The eradication of root knot from the soil is very difficult. It is best accomplished by running steam¹⁴ through lines of 3- or 4-inch tiles buried 18 to 22 inches apart and 15 to 18 inches deep or through perforated pipes laid temporarily. If drainage is required in the ginseng bed an adaptation of the tiles for double service should be considered. A temperature of 135° F. should be maintained throughout the soil for half an hour. Drenching it with large quantities of boiling water is a possible alternative, provided that the soil deeper than any roots have grown is heated to the above temperature. Pan steaming, formerly recommended, does not kill nematodes to a sufficient depth. No chemical treatment of soil has yet proved 100-percent effective.

To avoid losses from this disease, it is essential to start ginseng plantings in nematode-free land, using absolutely healthy roots or seed that has not been in contact with infested soil. Drainage water from

¹² Revision of this section prepared by Jocelyn Tyler, junior nematologist, Division of Nematology, Bureau of Plant Industry.

¹³ *Heterodera marioni* (Cornu) Goodey.

¹⁴ See footnote 6.

an infested area must not flow onto the new beds. Implements must be cleaned and thoroughly dried so as not to introduce any contaminated soil. Fertilizers and mulching materials must come from nematode-free sources.

YIELD AND VALUE OF THE CROP

The yield of cultivated ginseng varies greatly and depends largely on the suitability of the conditions under which the crop is grown and on the skill and experience of the grower. It has been estimated that the roots from a bed measuring 4 by 16 feet, if dug when 6 years old, should weigh about 10 pounds when dry. Yields of dry root from well-managed plantings appear to be at the rate of a ton to the acre, although much larger yields are frequently reported.

Ginseng has long been valued by the Chinese for medicinal use, though rarely credited with curative virtues by other peoples. The dried roots have been exported from the United States in increasing quantities since the early years of the eighteenth century, the prices rising as the wild supply diminished from about 40 cents a pound in the early years of its collection to \$24 a pound for the best qualities during 1927. Since then the price has declined greatly.

The cultivation of native ginseng, stimulated by its increasing scarcity and the rising prices, began in an experimental way about 1886, and for a time developed slowly. It is estimated that in 1901 a little less than 20 acres of ginseng were under cultivation in the United States, and, of the root produced, but a small quantity went into the market. In recent years the industry has attained such proportions that the output of cultivated roots appears to be considerably greater than that collected from the forests.

When cultivated ginseng first appeared on the market it sold at prices considerably higher than those paid for the wild root, but about 1904 the price declined to a figure less than that commanded by wild ginseng, and since that time it has for the most part remained at a lower level. The preference in the Chinese markets for wild ginseng over the American cultivated root appears responsible for the difference in the prices offered for wild and cultivated ginseng in the markets of the United States.

A negligible quantity of ginseng is consumed by Chinese residents of North America, and a trifle has been used by manufacturers of domestic medicine, leaving practically the sole outlet for ginseng with the Koreans and Asiatic Chinese. The domestic prices, exports, and valuation of American ginseng from 1914 to 1938, inclusive, are shown in table 1.

THE OUTLOOK FOR THE INDUSTRY

The future success of cultivated ginseng in North America will be determined to a great extent by the attitude of the growers. If the lessons taught by the experience of the preceding 25 years are heeded, the mistakes of the past need not be repeated, and many obstacles that have heretofore hampered the progress of the industry can be removed.

TABLE 1.—Domestic prices, exports, and value of American ginseng from 1914 to 1938, inclusive

Year	Domestic prices (per pound) ¹				Exports ²		
	Wild root		Cultivated root		Quantity	Total value	Average value per pound
	High	Low	High	Low			
	Dollars	Dollars	Dollars	Dollars	Pounds	Dollars	Dollars
1914.....	11.50	6.00	8.00	3.00	224,605	1,832,686	8.15
1915.....	9.50	4.50	7.00	2.00	103,184	919,931	8.91
1916.....	11.00	5.00	6.50	3.00	256,082	1,597,506	6.23
1917.....	14.00	6.00	7.00	2.50	198,480	1,386,203	6.98
1918.....	19.00	9.50	9.00	3.00	259,892	1,717,548	6.60
1919.....	23.00	13.00	12.50	3.00	282,043	2,057,260	7.29
1920.....	23.00	10.00	12.00	3.00	160,050	1,875,348	11.71
1921.....	12.00	6.50	8.00	1.00	181,758	1,507,077	8.29
1922.....	16.00	7.00	12.00	2.00	202,722	2,334,963	11.51
1923.....	18.00	12.00	15.00	3.00	148,365	2,245,258	15.13
1924.....	16.50	11.00	14.00	2.00	167,318	2,399,626	14.35
1925.....	15.00	7.50	13.00	2.00	138,131	1,668,221	12.07
1926.....	19.00	10.00	13.00	3.00	180,262	2,640,488	14.65
1927.....	24.00	12.50	13.00	4.00	169,000	2,556,000	15.12
1928.....	20.00	10.00	12.00	3.50	184,000	2,288,000	12.43
1929.....	18.50	10.00	12.00	2.00	234,000	2,766,000	11.82
1930.....	15.50	6.00	11.00	2.00	203,000	1,877,000	9.24
1931.....	12.00	5.00	9.00	2.00	265,000	1,922,000	7.25
1932.....	10.00	5.00	7.00	.75	171,000	835,000	4.88
1933.....	7.00	4.00	4.00	.50	233,000	844,000	3.62
1934.....	12.50	6.00	3.00	.25	232,000	1,203,000	5.23
1935.....	7.00	6.00	4.00	2.00	167,000	618,000	3.70
1936.....	7.00	6.00	4.00	2.00	296,000	1,236,000	4.19
1937.....	7.00	6.00	11.00	2.00	136,000	706,000	5.18
1938.....	7.00	6.00	11.00	10.00	167,000	1,028,000	6.15

¹ Prices for 1914 to 1931 were compiled from Hunter, Trader-Trapper, prices for 1932 to 1934 from Special Crops, and those from 1935 to 1938 from Oil, Paint and Drug Reporter.

² From annual reports of Foreign Commerce and Navigation of the United States.

The industry still suffers from the disrepute into which it was brought through exaggerated claims made by some dealers in seeds and nursery stock with regard to the possibilities for unusually large profits in the growing of ginseng. Although ginseng is a comparatively unimportant product in this country, it has a place among minor crops of recognized value. For every dollar's worth of ginseng exported in 1938 there were produced in this country about \$45 worth of peanuts, \$15 worth of onions, \$30 worth of strawberries, \$3 worth of asparagus, and \$5 worth of cranberries.

In comparison with that of other crops, the market for ginseng is small; consequently the industry affords an opportunity for only a limited number of persons without danger of becoming overcrowded. Because yields of the dry root from well-managed plantings appear to be at the rate of a ton to the acre, only a little more than 100 acres of mature ginseng could very readily supply 210,000 pounds of roots, which is the average exportation for the last 10 years. This would represent total plantings of nearly 600 acres, as it requires at least 6 years to grow marketable roots from seed.

The Chinese market formerly absorbed ginseng in quantities considerably in excess of the average exportations for the two decades just past. As shown in table 2, the number of pounds exported during the last 10 years is less than half of the exports for the 10 years 1860-69, and the average price per pound for the 10 years 1929-38 is nearly seven times as great as it was some 70 years ago.

TABLE 2.—*Exports and value of American ginseng for the periods indicated, from 1860 to 1938, inclusive*

Period	Quantity	Value	Average value per pound	Period	Quantity	Value	Average value per pound
	<i>Pounds</i>	<i>Dollars</i>	<i>Dollars</i>		<i>Pounds</i>	<i>Dollars</i>	<i>Dollars</i>
1860-69.....	4, 149, 445	3, 902, 209	0. 94	1900-1909.....	1, 513, 558	9, 610, 614	6. 34
1870-79.....	4, 041, 727	4, 537, 008	1. 12	1910-19.....	2, 047, 800	14, 823, 781	7. 24
1880-89.....	3, 457, 294	6, 771, 830	1. 95	1920-29.....	1, 764, 800	22, 280, 000	12. 63
1890-99.....	2, 163, 302	7, 843, 888	3. 62	1930-38.....	1, 896, 000	9, 634, 000	5. 15

As shown in table 1, the annual exports of ginseng root vary considerably from year to year without any pronounced trend with respect to quantity, but the market value of the root has declined more or less steadily since 1927, when it was \$15 a pound. This decline may be due to two causes, overproduction and a change in the proportion of cultivated and wild roots in the supply available for export. About 10 years ago there was quite an increase in the number of ginseng gardens, although accurate statistics indicating the change in the total acreage under cultivation and the number of growers in the last decade are not available. It is believed, however, that some overproduction may have occurred. The supply of wild ginseng is declining yearly, and, since the wild root is generally of higher market value than that from cultivated plants, a smaller proportion of the former in the exports would reduce the average value per pound.

The evident preference of the Chinese for the wild root and the unsatisfactory state of the general market for cultivated ginseng have caused grave doubts as to the future prospects of the industry. These doubts will probably be realized unless growers give more attention to the production of the type of root desired by the Chinese trade. In the future, growers should strive for quality of product and not for quantity of production, as has been the all too common practice in the past. There is always a ready sale for the cultivated roots which closely resemble the wild in quality and conditions, and prudent growers will not fail to adopt the wild root as the standard of future production. The elimination of the poorer grades of cultivated American ginseng, which are now found in the markets, would tend to insure more uniform prices for the root and to lessen the danger of depressing the market through overproduction.

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FARMERS' BULLETIN 1185
UNITED STATES DEPARTMENT OF AGRICULTURE

SPRAYING FOR THE ALFALFA WEEVIL



THIS BULLETIN, devoted chiefly to a description and illustration of the control of the alfalfa weevil by means of arsenical sprays, is intended for the man who is already well acquainted with the appearance of the pest and its effect upon his crop.

There are thousands of such farmers in Utah, Idaho, Colorado, and Wyoming, and their aggregate losses from this cause reach hundreds of thousands of dollars each year. The treatment described in these pages can be used throughout most of this territory and is suitable for both large and small acreages. It has been prepared during seven years of study and experiment and one season of thorough field trial in cooperation with farm bureaus, in the course of which over 4,000 acres were successfully sprayed by practical farmers, many of whom were without experience in any kind of spraying. The Farm Bureau News, of Sevier County, Utah, reports a saving of \$15,000 by this means and estimates from other sources raise the total to \$40,000.

Contribution from the Bureau of Entomology

L. O. HOWARD, Chief

Washington, D. C.

December, 1920

SPRAYING FOR THE ALFALFA WEEVIL.

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THE TURNING POINT IN WEEVIL INJURY DETERMINES THE TIME TO SPRAY.

THE BEST TIME TO SPRAY for the alfalfa weevil is determined by the progress of weevil injury in the alfalfa field. The seasonal activity of the weevil is as follows: The adult beetles or weevils, after hibernating in the fields, come out in early spring, feed sparingly upon the leaves and stems, and deposit eggs, at first in the softer dead stems on the ground and later in the green stems. The eggs develop slowly at first and faster as the temperature rises, until in May and June they hatch within two weeks after they are laid.

The feeding of the larvæ begins early in the spring and increases steadily until after the height of the hatching season in May, but the plants outgrow the injury until shortly before cutting time, when the young larvæ become so numerous that they completely destroy the growing tips and thus stop the growth of the plants (fig. 1). This is the *turning point in injury*, and after it is passed the appearance of the field changes rapidly; the leaves are consumed until nothing is left but woody fibers, and the tops of the plants are as white as if they had been frostbitten. This condition is shown in

figure 2. The injury spreads downward, and before the normal cutting time, if the field is allowed to stand, the whole plant is bare



FIG. 1.—The "turning-point" in alfalfa-weevil injury. The plant on the right is almost uninjured, that in the middle has reached the turning point, and that on the left is nearly destroyed.

of leaves and the green covering has been stripped from the stems. The feeding continues for two or three weeks longer and delays the growth of the second crop unless the larvæ are killed.

The *turning point*, then, coming from one to two weeks before the first crop is ready for cutting, is the best time to spray the field. The feeding larvæ are now most numerous and the conditions for poisoning them accordingly most favorable. On the other hand, the crop is not yet too badly damaged to recover quickly after the killing of the larvæ. Figure 3 shows the result of treatment at the proper time. The work may be done a week earlier or several days later, as the owner's experience and the character of the season may dictate. It has been done as early as April 20, entirely preventing damage to the crop, and in other cases it has been delayed until the plants had been stripped of their foliage, in spite of which they

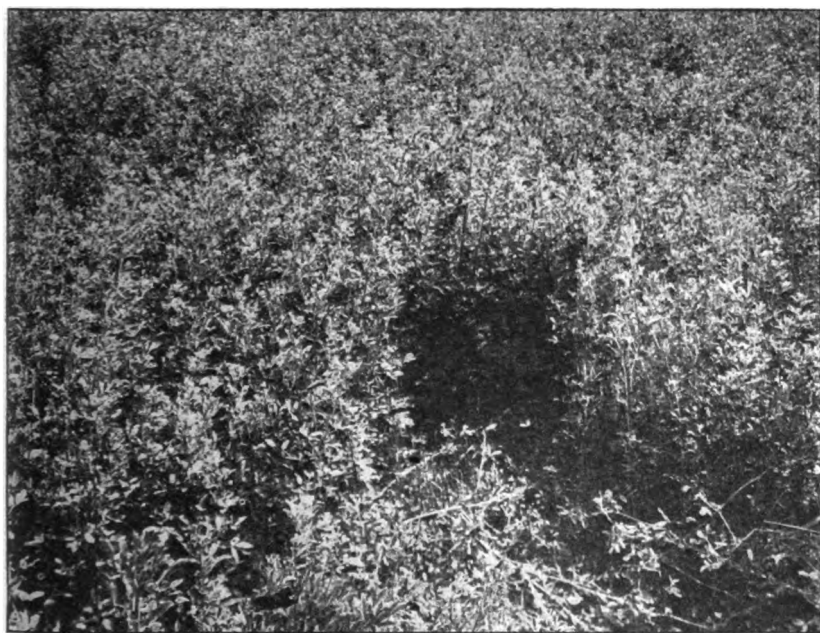


FIG. 2.—A field of alfalfa which has passed the turning-point. The lower foliage is still sound, but the tops are white and the buds have been killed.

were able to recover and bloom. The early spraying, however, is uncertain, as its success depends partially upon poisoning the adult beetles, which feed but little, while late spraying allows the destruction to go too far and makes recovery too slow.

THE TIME OF THE TURNING POINT IS GOVERNED BY WEATHER CONDITIONS.

The time of the turning point varies from year to year with weather conditions. If the weevils were affected by these conditions in the same way as the alfalfa it might be possible to name a definite stage in growth of the plant at which spraying should be done, but this is not always true.

In warm seasons the plants get an early start, which tends to postpone the turning point, but since this is more than offset by the rapid development of the weevils the damage is likely to come early. An extreme case of this occurs when the season is dry as well as warm: then the drought retards only the alfalfa, while the weevils develop without hindrance, and check the growth while it is still too small for profitable handling. It is in such circumstances that spraying yields its greatest returns.

In cold, backward seasons the situation is the opposite of that just described. The growth of the plants is hindered by the weather, but not so much as the weevil's egg laying, hatching, and feeding, and



FIG. 3.—First crop ready to cut, ten days after spraying. The white area is an unsprayed strip.

the crop becomes nearly mature before its growth is halted. In the abnormally late season of 1917, when in Utah March temperatures were delayed 30 days, and April and May temperatures 15 days behind the normal schedule, the first crop was fully mature before any injury had taken place, and the result was the only good first crop since the introduction of the alfalfa weevil. At such times the effect of spraying upon the first crop is least pronounced, and its effect upon the second crop becomes the principal consideration.

A heavy frost during the growing season has but little effect upon the insect, merely delaying the egg laying, hatching, and feeding for a few hours, but it may seriously stunt the alfalfa plants and thus

put them at the mercy of the weevil larvæ, somewhat as does the cutting of the first crop. Spraying has been done in such cases, apparently with good results, but this is still a matter for experiment.

In the average season the conditions lie between those of the two extremes just described. The checking of growth occurs about 10 days before the first crop is ready to cut, and spraying at that time enables the crop to finish its growth. This fully repays the cost of the treatment and is one of the principal arguments for it, especially in districts where the scarcity of late water makes the first crop the important one.

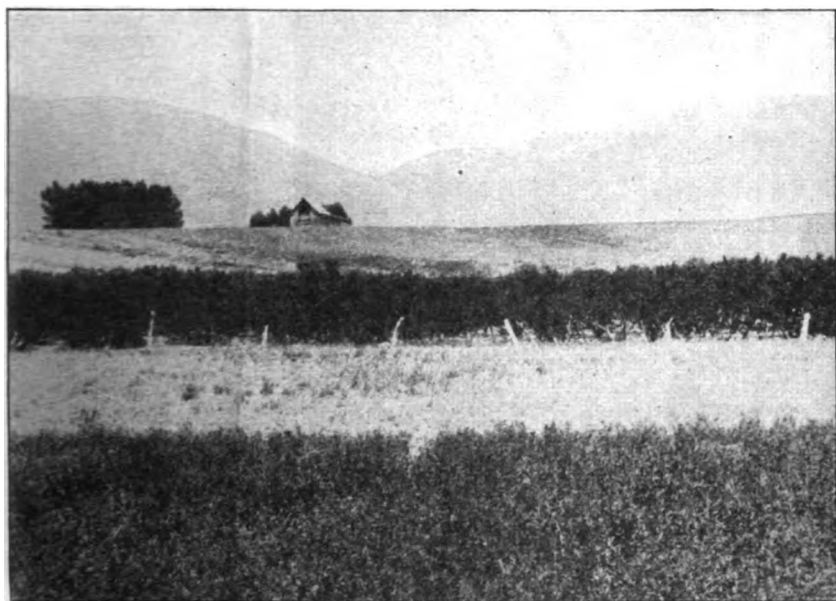


FIG. 4.—Second crop saved by spraying. The strip of bare stubble near the fence was left untreated at the spraying of the first crop.

SECOND-CROP PROTECTION.

In well-watered sections of the country, where a second crop can be grown, the profit realized by the first crop is only part of the results of spraying. The greater gain is in protection of the second crop, as shown in figure 4, from the larvæ which gather upon the small buds and prevent all growth during the three weeks or more that their feeding continues. Spraying produces a more uniform second crop than does brush dragging, as shown in figure 5. If the larvæ have been poisoned through spraying of the first crop, the second crop sprouts and grows without delay, and no treatment of the stubble is necessary.

STUBBLE SPRAYING NOT RECOMMENDED.

Stubble spraying has been successfully done by a number of farmers, but it requires getting upon the field immediately after cutting, which is not always possible, and further, a much larger quantity of liquid per acre is needed than if it were applied to the first crop. In years when the damage to the first crop is slight it might seem more convenient to cut it first and then spray the stubble, but the results of many trials show that this is not usually true. The time to poison the larvæ most easily is when they are feeding upon the tips of the first crop, and not when they are clustered below the surface of the

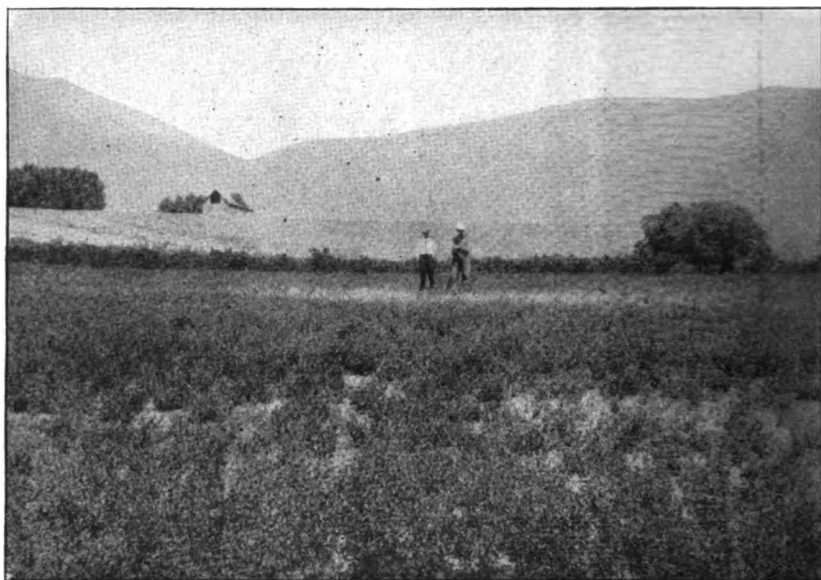


FIG. 5.—Brush-dragged portion of field shown in figure 4. The uneven growth is a characteristic result of this treatment.

ground upon the buds of the stubble. Stubble spraying can only be advised when earlier spraying has been impossible.

PREPARATION OF MACHINERY.

Before using spraying machinery it is necessary to overhaul and repair it. To make sure that the nozzles, hose, and connections, and the packing of valves, pistons, and cylinders are in good condition, the engine in working order, and the pump and pipes free from rust and scale, takes about three days, and should be done long enough in advance so that the necessary repairs will be finished in time. Spraying is less profitable if too much cleaning and repairing are left to be done after spraying begins, while the crew waits and the weevils destroy the hay crop.

If machinery must be purchased or hired and fitted for alfalfa spraying, it should be ordered months in advance. Local dealers in any community where people are beginning to spray for the alfalfa weevil are likely to have sold out their stock long before the season has begun.

NECESSARY EQUIPMENT.

The necessary equipment for spraying alfalfa consists of (1) a truck or vehicle; (2) a tank with an agitator; (3) a pump; (4) a pressure gauge; (5) an engine and pumping jack, unless the pump is to be driven by hand; (6) a strainer; (7) a boom or pipe, for distributing the liquid from the pump; and (8) spray nozzles.



FIG. 6.—A homemade spray outfit. No part of this equipment was originally designed for spraying. Even the nozzles were homemade. In convenience and utility it is equal to any spray machinery manufactured.

These essentials may all be contained in a barrel-pump outfit carried in a wagon, or they may be in the form of a 200-gallon tank mounted with a gasoline engine and pump on a special frame and truck. Any pump, with brass lining, valves, and pistons, capable of delivering four-fifths of a gallon or more per minute and maintaining a pressure of 75 pounds, can be used for this purpose on a scale suited to its size. Figure 6 shows a spray outfit which was assembled under difficulties from materials already on hand.

CAPACITY OF THE OUTFIT.

The size of the outfit should be adapted to the work it is to perform and can best be calculated by beginning at the nozzle and

taking up the various items in an order nearly the reverse of that in which they have just been mentioned. The best results have been obtained with nozzles working 2 feet above the alfalfa, each nozzle as it moves across the field spraying a strip 2 feet wide. A single nozzle in spraying an acre, which is 43,560 square feet, therefore covers a strip 2 feet wide and 21,780 feet long, or, in other words, travels 21,780 feet. It is now considered desirable to apply 100 gallons per acre, and in order to do so the nozzle must deliver $1/21,780$ of that quantity to each linear foot of the strip; and as 200 feet per minute is an average walking gait for a team hauling the outfit, the nozzle must deliver $200/21,780$ of 100 gallons, or 0.9 of a gallon per minute.

The same figures show that the time required to spray an acre with one nozzle is $21,780 \div 200$, or 109 minutes. If twice as many nozzles are used the strip sprayed will be twice as wide and one-half as long, and the time required will be one-half as great; and so the time and the amount of driving required will vary as the number of nozzles is increased, but the rate of flow of each nozzle must be kept the same so long as the driving gait and the quantity per acre are unchanged.

Knowing the number of gallons with which each nozzle must be supplied per minute it is easy to compute the capacity required of the pump for a given number of nozzles, or the number of nozzles which a given pump will support. It is also possible to calculate how large an outfit will be needed to spray a given area in a given time, or how large an area a pump already on hand can spray in a given time, according as the controlling factor is the kind of pump which is available, the number of acres which must be sprayed, or the time which can be devoted to it. Thus 10 nozzles, each discharging 0.9 of a gallon per minute, will require a pump which can deliver 9 gallons in that time, and such an outfit will spray an acre in about 11 minutes of actual work. Such a machine is shown in figure 7.

The capacity of a pump depends upon the size of the plunger, the length of its stroke, and the number of strokes per minute, and can therefore be ascertained by a simple calculation. The area of the plunger is found by dividing its diameter, in inches, by 2, multiplying the result by itself, and that result again by 3.1416. This result, multiplied by the length of the stroke in inches, gives the contents of the cylinder in cubic inches, which is reduced to gallons by dividing by 231, and gives the quantity delivered by a stroke of the pump. If the latter is double-acting, as most of the better spray pumps are, this must be multiplied by 2. The delivery per minute is then obtained by multiplying the number of gallons per stroke by the number of strokes per minute.

One-cylinder pumps operated by hand are usually rated on the basis of 30 strokes per minute, and those driven by power at 50 strokes per minute. Duplex and triplex pumps are driven at a speed of 40 to 50 revolutions per minute, giving, respectively, 80 to 100 strokes per minute for the former and 120 to 150 for the latter.

If it is necessary to estimate the size of pump needed for a given kind of work the process is reversed; for example, it has just been shown that a 10-nozzle outfit applying 100 gallons per acre and traveling 200 feet per minute uses about 9 gallons per minute. To maintain this flow a power pump at 50 strokes per minute must deliver $9 \div 50$, or 0.18 gallon per stroke. If it is a double-acting pump,

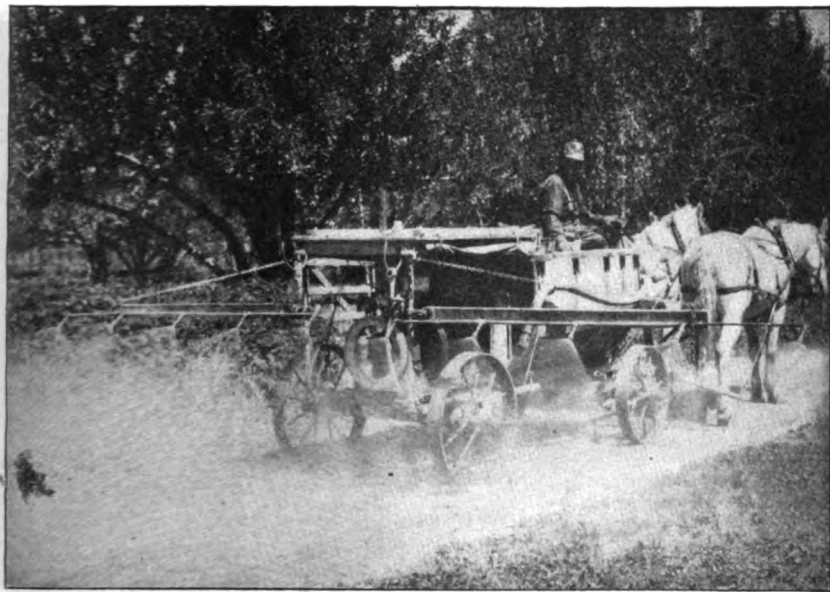


FIG. 7.—An excellent outfit adapted for alfalfa-weevil spraying by the Colorado Experiment Station in cooperation with the authors.

each stroke fills and empties the cylinder twice, and the contents of the cylinder must be 0.09 of a gallon or 20.79 cubic inches. The area of a 3-inch plunger is 1.5 by 1.5 by 3.1416, or 7.0686 square inches, and the length of stroke required to give a capacity of 20.79 cubic inches is therefore $20.79 \div 7.0686$, or 2.9 inches. A 2½-inch cylinder would need to have a stroke of about 4¼ inches.

A triplex pump operated at 50 revolutions (150 strokes) per minute would need only one-third the capacity of a single-cylinder pump, 0.06 gallon. Calculation shows that this can be obtained with a 2½-inch cylinder and 2½-inch stroke.

Table I gives the flow per stroke, in fractions of a gallon, of the common sizes of double-acting pumps.

TABLE I.—Capacity of cylinders of double-acting spray pumps, in fractions of a gallon.

Diameter of cylinder, in inches.	Length of stroke, in inches.			
	2½	3	4	5
2	0.068	0.082	0.109	0.136
2½	.086	.103	.139	.172
2¾	.106	.127	.170	.212
3	.129	.154	.206	.257
3½	.153	.184	.245	.306

The smallest barrel pumps will hardly supply a single nozzle, and can only be used for small patches of alfalfa, while some double-acting hand pumps with 3 by 5 inch cylinders deliver as high as 9 gallons per minute, and therefore are capable of supporting 10 nozzles. Such a pump will spray an acre in about 11 minutes, if labor is available to keep it going at 30 strokes per minute. The same pump driven by a 2-horsepower gasoline engine at 50 strokes per minute will deliver 15 gallons per minute and easily supply 10 nozzles, each delivering 1½ gallons. This is 25 per cent above the requirements of an outfit moving 200 feet per minute and makes it possible to drive 250 feet per minute and spray an acre in nine minutes.

Modern orchard spray outfits are usually of the duplex or triplex type with small cylinders and short stroke, and are designed to give a comparatively small flow and high pressure. They are less suitable for alfalfa spraying than the older pumps with larger cylinders and longer stroke, designed for larger flow and lower pressure. Seventy-five pounds pressure is enough for successful spraying for the alfalfa weevil, although it is possible that a better distribution of the poison is obtained at a pressure of 100 to 125 pounds. Higher pressures cause needless wear and strain upon the machinery.

The necessary capacity of an outfit having been decided upon, it remains to select the parts to conform to it and to the conditions under which the work must be done. Capacity is not the only thing to be considered in selecting or assembling an outfit. The truck, tank, pump, engine, boom, and nozzles can be chosen in such a way as to avoid later trouble and expense.

THE VEHICLE.

Almost any kind of wagon or truck can be used to haul the equipment. For a light outfit an express wagon or an ordinary farm wagon, preferably with no sides, is satisfactory. If planks are used for the bed, the engine, pump, and jack can be bolted to one of them. If an ordinary wagon box is used, a plank to which the machinery is bolted can be slid into it lengthwise and nailed or bolted down.

For a permanent structure a frame of 4 by 6 inch timber may be fitted to the wagon and a 200-gallon tank mounted with the other machinery upon it. The most convenient homemade truck is a flat rack. Commercial orchard spray trucks, usually furnished with low wheels and broad tires, may be used, but high wheels, are better for spraying tall alfalfa, not because they break down less alfalfa, since this is only temporary, but because they make it easier to attach the spray boom at the proper height, and cause less jolting of the machinery in driving over rough ground.

THE TANK.

Commercial spray tanks are usually in the form of a half cylinder, made of redwood, cypress, or steel, with a capacity of 200 gallons. Homemade tanks are usually 50-gallon barrels, four of which, with an engine and pump, can be carried on an ordinary wagon or a flat rack. Two hundred gallons of water is load enough for a team in most fields. If the water has to be hauled a long distance a second team and a thrasher tank should be used for that purpose instead of the spray outfit.

The most important item connected with the tank is the agitator. Since the poison is not dissolved in the water, but merely mixed with it, it will gradually settle to the bottom of the tank, leaving only a weak mixture to be applied to the plants, unless the liquid is stirred constantly and vigorously. For this purpose commercial outfits use a paddle or propeller within the tank, operated by a shaft, sprockets, belt, or drive rod from the pump or jack. In barrels the liquid can be stirred by a paddle or dasher worked by the jack or pump or by hand.

A strainer of 20-mesh brass or bronze screen should be fitted over the opening through which the water enters the tank and another over the outlet from it which leads to the pump. The former may be at the end of the suction hose, if one is used for filling the tank. If a cloth cover is used to keep the tank or barrels from slopping over it should be of canvas rather than burlap or any other linty fabric.

THE PUMP.

In spray pumps of all sizes certain structural features are important because of the corrosive nature of the liquid and the need of a uniform flow at comparatively high pressure.

The cylinder lining, plunger, valves, valve seats, and other working parts in which a close fit is required, and which also come in contact with the arsenic, must be of brass, bronze, porcelain, or some other substance which is less rapidly corroded by the chemicals than are iron and steel. To maintain the pressure without waste of power

requires carefully fitted valves and properly packed stuffing boxes. All commercial spray pumps are built in this way, but pumps which were intended for other purposes should be refitted when used for spraying.

The suction hose leading from the tank to the pump should be 1 inch in diameter, with a heavy wall to prevent collapse. About 10 feet of it is needed.

Every engine-driven outfit must have a relief valve near the pump, permitting the surplus flow to return to the tank. This regulates the pressure and also acts as a safety valve to prevent the development of dangerously high pressures when the outlet is purposely or accidentally closed.

The pump must have an air-pressure chamber large enough to keep the flow steady and thus insure even distribution of the poison. Its capacity in gallons for a double-acting or duplex pump should be about equal to the number of gallons per minute discharged by the pump, which is much more than the capacity of the chamber usually furnished with force pumps and even of many spray pumps which are intended to be used with a smaller number of nozzles. Triplex pumps need air chambers only two-thirds as large. The pressure chamber should be attached to the line near the pump, but not between it and the relief valve, and it should be mounted in a vertical position to enable the settlings to drain out. It is best to provide the pipe leading to it with a check valve to retain the pressure in the chamber without strain upon the pump.

A cut-off should be inserted between the pressure chamber and the strainer (described below), to prevent loss of pressure during short stops. A plumbers' stop-and-waste cock is suitable for this purpose because it opens and closes with a single motion. The two ends are not alike, and it must be attached so that the closed end is toward the pump when the cock is turned off.

THE PRESSURE GAUGE.

A pressure gauge is necessary for good work with either a large or small outfit, because it is impossible without it to maintain the even pressure which is indispensable for the uniform spread of the poison. The gauge should be attached to the air-pressure chamber, or near it, and at a distance from the relief valve and the nozzles.

THE STRAINER.

Clogging of the nozzles by rust, scale, and fibers from the interior of the pump and the pipes can be prevented by inserting a strainer, so constructed that it can be cleaned easily, at some convenient place

in the pressure line beyond the cut-off (fig. 8). A 1½-inch T is used as the shell, and the pipe from the pump is screwed into its middle opening. The T is turned so that the other two openings point up and down and a plug is screwed into the lower opening whence it can be removed to clean out the strainer. The strainer itself is a cone of 20-mesh brass or bronze screen strengthened by crossed hoops of No. 14 galvanized wire, both soldered to the inside of a 1½ by 1½ inch bushing, which is then screwed into the upper opening of the large T so that the cone points down into the T. This bushing is connected by suitable bushings with the hose leading to the boom. The spray

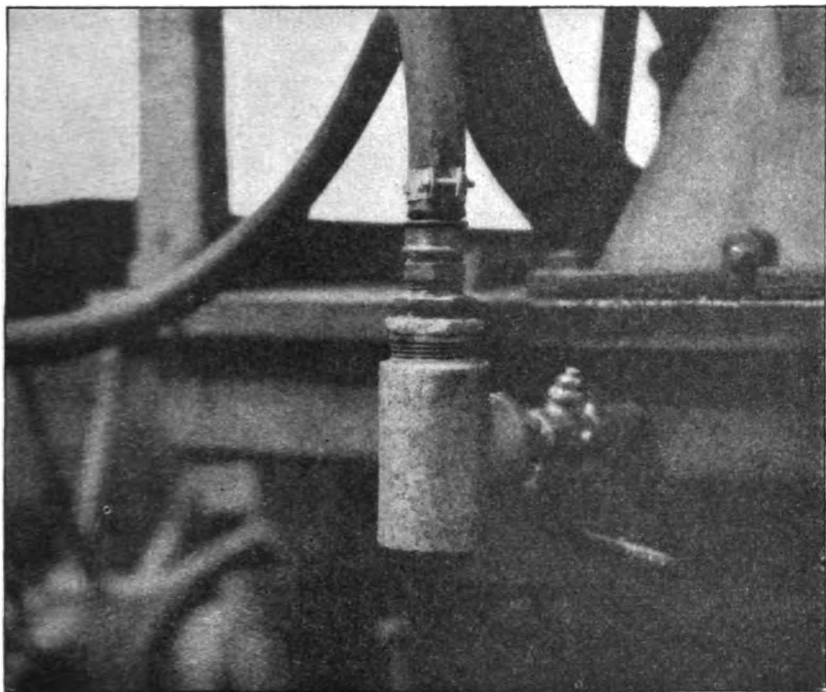


FIG. 8.—Pressure strainer attached to spray outfit.

liquid from the pump enters the shell at the side opening and flows upward through the screen cone and out at the top toward the nozzles, leaving the dirt on the outer lower side of the cone, from which it can be removed after taking out the bottom plug (fig. 9).

THE ENGINE.

The capacity of the gas engine should be about 1 horsepower for each 4 gallons per minute pump capacity. The power is transmitted to the pump through a jack, driven by a belt or gears, which should give a gear reduction of about 10 to 1. Some spray pumps are built with a crank shaft or eccentric shaft, which takes the place of the jack.

THE BOOM.

The boom which carries the nozzles and supplies them with liquid from the pump is made of 2-foot pieces of $\frac{1}{2}$ -inch galvanized-iron

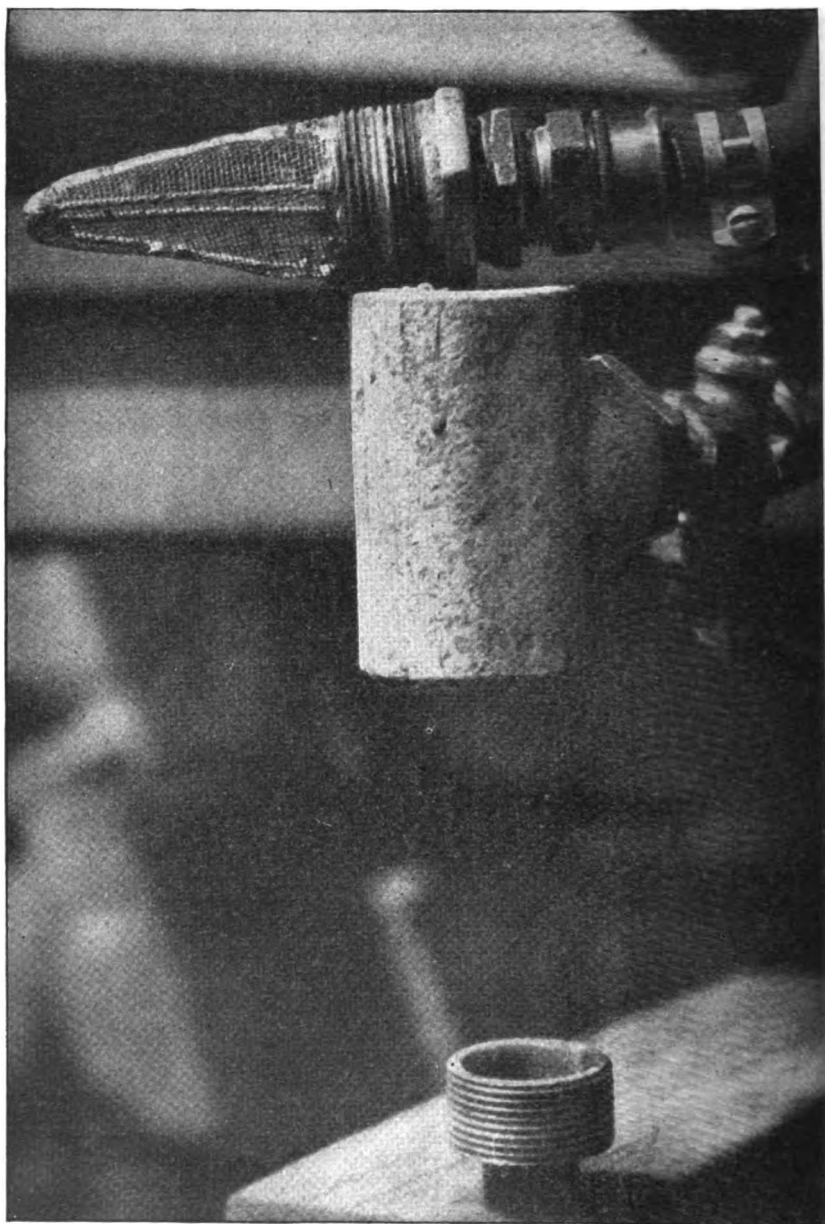


FIG. 9.—Parts of strainer shown in figure 8.

pipe, joined by tees, each of which affords an opening for the attachment of a nozzle. The boom may be all connected in one piece, in which case a cross must be used in place of one of the central

tees to allow for the hose connection with the pump, or it may be built in two independent halves, each swung separately from the frame of the vehicle and supplied by a separate pressure hose from the pump. In case the pump has but one lead and another is desired, it may be provided by adding a T or a Y. The divided boom is more convenient than the other for driving through gates and, the parts being shorter, is less likely to be broken on rough ground.

The boom is connected with the pump by a $\frac{1}{2}$ -inch, 5-ply or 7-ply pressure hose, to which it is joined by a hose coupler having a $\frac{1}{2}$ -inch pipe thread on one end and a $\frac{3}{4}$ -inch hose thread on the other. The attachment of the nozzles to the boom is provided for by fitting each T with a $\frac{1}{2}$ by $\frac{1}{4}$ inch bushing and a $\frac{1}{4}$ -inch nipple about $1\frac{1}{2}$ inches long, which fits the $\frac{1}{4}$ -inch female thread of the nozzle.

The boom, whether in one piece or two, should not be expected to support its own weight. The best support is a 2 by 4, clamped or hinged to the truck, with the boom stapled, bolted, or wired to it. This prevents the slender pipe from whipping and breaking at the threads. The one-piece boom must be attached so that it can be quickly unfastened and removed when the outfit is driven through a gate. An advantage of the 2-piece boom is that the wings can be hinged so as to swing out of the way.

Twenty feet is the limit of length for the spray boom, owing to the amount of swinging at the ends caused by the wheels of the truck when moving over rough ground. Even when a shorter boom is used it is best to keep on hand one or two extra tees and sections of pipe to repair accidental breaks.

THE NOZZLES.

Plain nozzles, designed to give a misty spray, sometimes called hollow-cone, eddy-chamber, cyclone, whirlpool, and cover-spray nozzles, without strainers or other complications, are best for this work, since the purpose is to place a fine, even coating of poison upon the upper foliage, where the larvæ chiefly feed. This kind of nozzle has a base threaded to fit a $\frac{1}{4}$ -inch pipe. On the other end is screwed a brass cap which holds in place the steel discharge disk with its central discharge opening, and back of that a gasket $\frac{1}{8}$ inch thick, within the circle of which is the eddy chamber or whirlpool chamber, which breaks the jet of water into a hollow cone of fine mist and gives the nozzle its various names. Back of this space is the directing disk, a flat piece of metal pierced with one or two holes situated midway between the center and the edge and slanted so that the liquid passing through them gives a whirling motion to the contents of the eddy chamber. This disk should be removable from the body of the nozzle for cleaning, but it

is sometimes a part of the single-piece shell. For alfalfa spraying it should not have a central direct hole such as some orchard nozzles have.

The rate of flow of a nozzle depends upon many details of size, shape, and design, but in nozzles of the same pattern it is governed by the size of the discharge opening and the pressure supplied by the pump. Thus a certain nozzle which is in common use, when provided with a five sixty-fourths-inch opening and a pressure of 125 pounds, delivers a little more than four-fifths of a gallon per minute. For each additional 25 pounds of pressure the flow is increased one-sixteenth gallon. The same nozzle with a six sixty-fourths-inch opening delivers as much liquid at 75 pounds as with a five sixty-fourths-inch opening at 150 pounds, and increases one-eighth gallon for each added 25 pounds.

The discharge disk must be renewed occasionally, because the continued friction of the liquid wears away the edges of the opening, enlarging it and increasing the rate of discharge so that the material is wasted and eventually it becomes impossible to maintain the proper pressure.

There is some difference of opinion as to whether the nozzles should point directly downward or slant backward. The writers have tried various angles and failed to find any advantage in one position over the others.

The character of the spray produced by a plain nozzle of the type described in the foregoing paragraphs depends principally upon the pressure. With pressures below 75 pounds many of the particles of spray are so large that they roll down the surfaces of the foliage, collect in drops, and fall to the ground. At 75 pounds pressure the particles remain separate long enough to dry and form a fairly even coating, and as the pressure increases the spray becomes finer and the cover more nearly perfect. As the success of the work depends largely upon covering as nearly as possible all the upper foliage, the pressure should not fall below 75 and might well be kept at 100 to 150 pounds.

TOOLS.

The tools needed in fitting up and using a spray outfit are, in addition to the usual hammers and wrenches, two 12-inch or 14-inch Stillson wrenches and a pair of pliers. The cutting and threading of the pipe used for the boom can be done at a plumber's shop more economically than by buying the tools which would be required for doing the work at home.

THE POISON.

Arrangements should be made for obtaining the poison at the time when the machinery is being purchased or overhauled. Ar-

senate of lead and arsenite of zinc have been used on a large number of fields with complete success, and it is likely that other arsenical poisons which are recommended for orchard spraying are equally good. There is practically no danger of burning the foliage of alfalfa, and therefore the range of suitable poisons is larger than in fruit-tree spraying. The principal considerations are the cost of the poison and its capability for sticking to the leaves, and in both these respects arsenate of lead is slightly superior.

The dry, powdered form of the poison is better than the paste, because it costs less to ship and keeps better from year to year.

The poison is made much more effective by adding soap to make it spread more readily and stick to the leaves, which are so hairy that the particles of spray tend to collect in larger drops and run off.

The poison is weighed or measured for use at the rate of 2 pounds of the powder or 4 pounds of the commercial paste for each 100 gallons of water, and is stirred with a little water in a pail until it becomes a thin paste without lumps. It is then diluted and strained into the tank through brass milk-strainer gauze, which may be mounted for the purpose on a hoop or a frame which fits the opening in the tank. Two pounds of laundry soap for each 100 gallons is added.

The materials and utensils should be kept free from dirt and lint, which might later cause clogging of the nozzles, and when cloth is used for straining liquids or covering containers it should be canvas or muslin and not a linty fabric like burlap. The spray liquid should be mixed just before use and kept stirred up until it is all used, to prevent the settling and wasting of the poison and the clogging of the pipes.

APPLICATION OF THE SPRAY.

The spray outfit is ready for work when the tank, pump, pipes, and nozzles have been cleaned and, together with the engine, tried and found to be in working order and regulated so as to deliver 100 gallons of spray mixture per acre and maintain a pressure not lower than 75 pounds.

The weather most favorable for spraying is at the beginning of a warm period, because in warm weather the larvæ feed more freely and it is desirable to have them do so for several days immediately after the application of the poison. If it is put on just before a cold spell the weather may cause some of the feeding to be postponed until the alfalfa has grown a few inches and provided fresh unpoisoned food for the larvæ. Nevertheless, good results have usually been obtained in spite of unpromising weather, and all that is necessary is to give the poison a chance to dry thoroughly upon the foliage before it is exposed to storms.

One man is needed to drive the team and another to operate the machinery, if a power outfit is used. The number of men needed with a hand pump depends upon its size; the smaller pumps can be worked by one man, but the larger ones require two men or even three, each working two-thirds of the time.

Twenty-five acres can be covered easily in a day with a 10-nozzle machine, and this speed, with the low cost and the protection given to both crops at one operation, makes the spraying method superior to all others for the control of the alfalfa weevil. The actual cost is about \$1 per acre, and growers who did the work for their neighbors in 1919 charged from 75 cents to \$2, in addition to the cost of the poison, which was 60 cents per acre.

The results of the work begin to appear in about three days, and many dead larvæ can then be found, but the full effect is not obtained until the fifth day. By that time from two-thirds to nine-tenths of the larvæ have perished and the field takes on a brighter green. Remarkable contrasts are often produced by leaving a small strip unsprayed, as shown in figure 3.

DANGER OF POISONING STOCK.

There have been many inquiries as to the danger of poisoning live stock by feeding sprayed hay, which are all answered by the fact that such hay is shown by analyses and feeding tests to contain too little poison of any kind to injure farm animals. Many of the cattle which are fed upon it probably take in more arsenic with their drinking water than with their hay, and as for the lead content, few of them would under any circumstances live long enough to show the least effect of it.

CONCLUSION.

Seldom has any newly recommended method of insect control been so thoroughly safeguarded against failure as alfalfa weevil spraying. It has been tested every season for seven years, and the conditions necessary to success have been carefully ascertained. It is believed that most of the difficulties have been provided against, and it is certain that the farmers who tried it in 1919 are satisfied. The cost of the operation is trifling compared with the returns. Improvements will doubtless be made in the machinery and the arsenical poisons, but the method is at present a practical success, and no farmer in the territory infested or threatened by the alfalfa weevil can afford to overlook it.



FARMERS' BULLETIN 1186
UNITED STATES DEPARTMENT OF AGRICULTURE

PORK ON THE FARM

KILLING CURING AND CANNING



EVERY FARM should produce the pork and pork products which are consumed on that farm.

Selling hogs and buying pork involves profits, but not for the farmer engaged in the practice.

Home curing of pork is an old practice. It nearly went out of style, but the style is rapidly becoming popular again.

Home-cured pork, fresh-canned pork, sausage, pudding, scrapple, headcheese, pickled pigs' feet, and lard afford a variety of products to supplement the daily meals.

Preparations of highly nutritious and palatable pork products for home use are easily made.

This publication discusses the details of converting the farm-grown hog into high-class, appetizing, nutritious foods available for use in the fresh, cured, or canned state at any season of the year.

Joint Contribution from the Bureau of Animal Industry

JOHN R. MOHLER, Chief

And States Relations Service

A. C. TRUE, Director

Washington, D. C.

February, 1921.

PORK ON THE FARM.

KILLING, CURING, AND CANNING.¹

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MEAT ANIMALS, especially hogs, may be raised and the meat cured at home for much less than the cost of purchased meat. A market for good country-cured hams, shoulders, and sides is easily found. In spite of these facts, however, the practice of purchasing cured meats has increased among farmers. It may not be practicable for every farmer to butcher and cure the meat from all the hogs he grows, but in nearly every community a few farmers could do it and make good profits. Farmers who sell country-cured meats have very little difficulty in establishing a permanent trade. To accomplish it one must understand the kind of cured meat the trade demands. A well-marbled, juicy, savory piece of meat showing the proper admixture of fat and lean, properly cured and possessing a good flavor, is the kind the consumer desires.

SELECTION OF HOGS FOR BUTCHERING.

HEALTH.

In selecting hogs for butchering, health should have first consideration. Even though the hog has been properly fed and carries a prime finish, the best quality of meat can not be obtained if the animal is unhealthy; there is always some danger that disease may be transmitted to the person who eats the meat. The keeping quality of the meat is always impaired by fever or other derangement.

¹ This bulletin supersedes Farmers' Bulletin 913, *Killing Hogs and Curing Pork*.

CONDITION.

A hog in medium condition, gaining rapidly in weight, yields the best quality of meat. Do not kill a hog that is losing flesh. A reasonable amount of fat gives juiciness and flavor to the meat, but large amounts of fat are objectionable.

QUALITY.

The breeding of animals plays an important part in producing carcasses of high quality. Selection, long-continued care, and intelligent feeding will produce meat of desirable quality. Smooth, even, and deeply fleshed hogs yield nicely marbled meats.

AGE FOR KILLING.

The meat from very young hogs lacks flavor and is watery, and that from old hogs generally is very tough. The meat of old hogs will be improved, however, if they are properly fattened before slaughter. Hogs may be killed for meat any time after 8 weeks of age, but the most profitable age at which to slaughter is when from 8 to 12 months old.

TREATMENT BEFORE SLAUGHTER.

Hogs intended for slaughter should not be kept on full feed up to the time of killing. It is better to hold them entirely without feed for 18 or 24 hours prior to that time, but they should have all the fresh water they will drink. This treatment promotes the elimination of the usual waste products from the system; it also helps to clear the stomach and intestines of their contents, which in turn facilitates the dressing of the carcass and the cleanly handling and separation of the viscera. No animal should be whipped or excited prior to slaughter.

EQUIPMENT FOR SLAUGHTERING.

It is essential to have the proper equipment for rapid and skillful work at killing time: A straight sticking knife, a cutting knife, a 14-inch steel, a hog hook, a bell-shaped stick scraper, a gambrel, and a meat saw (fig. 1). More than one of each of these tools may be necessary if many hogs are to be slaughtered and handled to best advantage. A barrel is a convenient receptacle in which to scald hogs. The barrel should be placed at an angle of about 45 degrees at the end of a table or platform of proper height. The table and barrel should be fastened securely to protect the workmen. A block and tackle will reduce labor. All the tools and appliances should be in readiness before beginning.

KILLING AND DRESSING.

Ordinarily it is not necessary to stun or shoot a hog before sticking, although sometimes it is done. If the hog is stuck without being stunned, it should be squarely on its back when stuck. Two men can reach under and grasp the legs on the side of the body opposite to them and with a quick jerk turn the hog over on its back. One man can stand astride the body with his legs just back of the hog's shoulders, taking a good grip on the forelegs (fig. 2). In this position the hog can be held in place while the other man does the sticking.

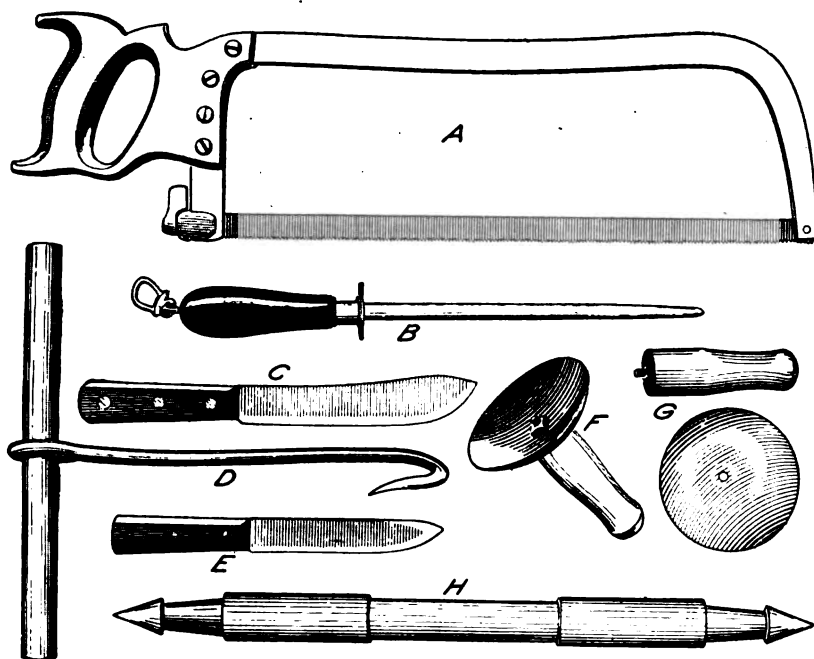


FIG. 1.—Tools for killing and dressing hogs. A, meat saw; B, 14-inch steel; C, cutting knife; D, hog hook; E, 8-inch sticking knife; F, bell-shaped stick scraper; G, separate parts of stick scraper; H, gambrel.

STICKING.

A narrow, straight-bladed knife (see E in fig. 1) serves well for sticking a hog. The knife should be pointed directly toward the root of the tail and held in a line with the backbone. Thrust the knife in directly in front of the breastbone, and keep in a straight line so as not to stick a shoulder, causing blood to clot, which results in waste in trimming or a shoulder which keeps poorly. After the knife has been inserted 6 or 8 inches, turn it and withdraw. This severs the vessels in the neck and insures better bleeding. Avoid sticking the

heart, for in that case the blood will not be pumped from the arteries. After sticking, the hog may be released; but preferably the animal may be strung up by a hind leg to facilitate thorough bleeding.

SCALDING AND SCRAPING.

The most convenient vessel in which to heat water for scalding is a large caldron or a kettle, which should be located near the place of butchering. If the water is heated in the house, it should be boiling when removed from the stove. If the hog is not too large, a barrel may be used for scalding. The arrangement for most efficient scald-

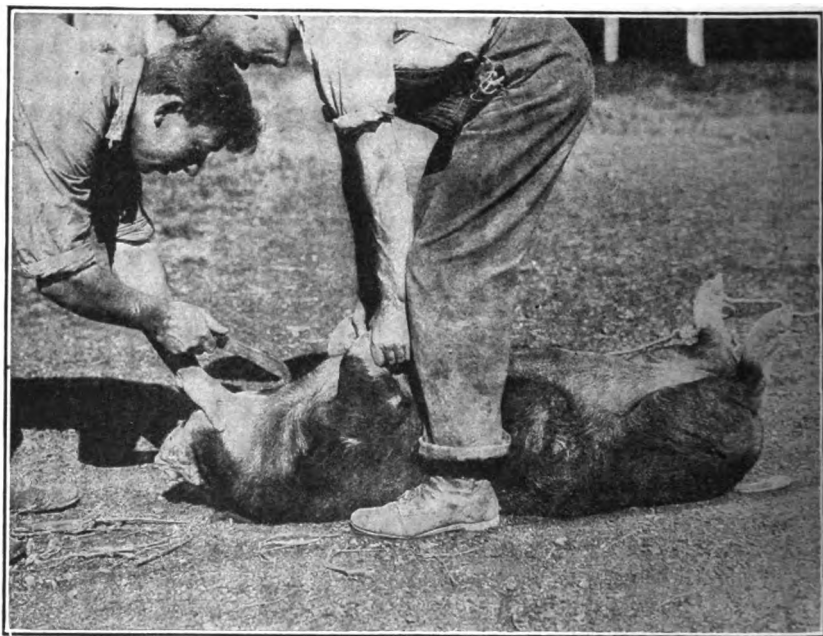


FIG. 2.—Position for sticking the hog.

ing is shown in figure 3. If the barrel is not large enough to accommodate the hog, a blanket or several sacks may be laid over the carcass and scalding water poured over it. The blanket or sacks will retain the moist heat long enough to loosen the hair.

At the time the hog is scalded the water should have a temperature of from 145° to 155° F. If the water is too hot the hair may set, causing even more trouble than if too cold. A teaspoonful of lye or a small shovelful of wood ashes added to every 30 gallons of water will aid in removing the scurf. After adding either of these materials the water should be stirred thoroughly.

If the barrel is used, insert the hog hook in the lower jaw, place the hog on the table, and slide it into the barrel (fig. 3). The rear end of the hog is scalded first for the reason that if the water is too

hot and the hair sets it can be removed more easily from the rear than from the fore part. The hog should be kept moving in the water to be sure that no part rests against the side of the barrel. Occasionally the hog should be drawn out of the water to air, when the hair may be "tried." When the hair and scurf easily slip from the surface, scalding is complete. The same test for determining whether scalding has continued long enough may be used when blankets or sacks are used, and the dressing of the carcass should also proceed in the same manner. Pull the hog out upon the table and quickly remove the hair and scurf from the legs and feet. The simplest way to do this is to twist the legs in both hands. Use the

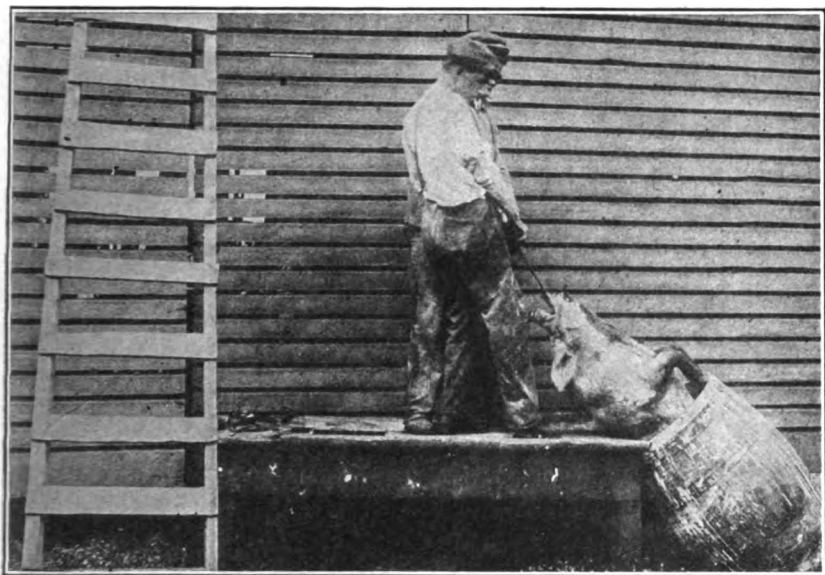


FIG. 3.—A convenient arrangement for scalding.

hog hook to remove the dewclaws while they are still hot. Remove the hair and scurf from the rear end of the hog by means of a bell-shaped scraper.

Cut the skin lengthwise for about 3 or 4 inches just below the hocks in both hind legs. Loosen the tendons in each leg and insert the gambrel. Scald the front part of the hog and pull it out on the table as before. Remove the hair and scurf immediately from the ears, forelegs, and head, as those parts cool very quickly. Use the bell-shaped scraper to remove the remaining hair and scurf. If the hair fails to yield in any particular part, cover that portion with a gunny sack and pour on hot water. When most of the hair and scurf is removed pour hot water over the entire carcass and by means of a knife shave off any hair that is left. Hang the hog up, pour a bucketful of cold water over it, and scrape off the remaining dirt or scurf.

Much of the heavy labor may be avoided by use of a hoist, such as a block and tackle, for lifting the hog.

REMOVING ENTRAILS.

After the hog is hung up and the surface is clean the next step is to remove the entrails. Cut through the mid line, beginning at the top, and continue cutting down to the head. Cut around the rectum on each side and pull it out between the pelvic bones.

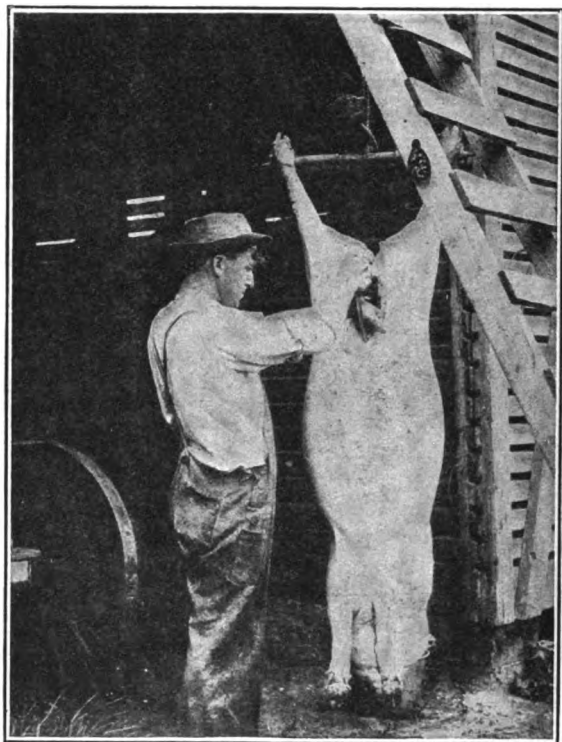


FIG. 4.—Removing the Intestines.

Place the knife between the first and second fingers of the left hand, inserting the fingers where the opening has been made, and with the right hand carry the knife down the body and force through the breastbone to the opening in the neck. The fingers will serve as a guide in making the cut and will protect the intestines. When the opening has been made, remove the fat which surrounds the stomach. Remove the intestines, stomach, and gullet in one operation, thus preventing contamination of the

carcass by the stomach contents. Remove the pluck, consisting of the heart, lungs, and windpipe, after cutting the diaphragm, which is the membrane that separates the organs of the chest from the stomach, bowels, and other abdominal organs. By cutting between the light and dark portions of the diaphragm and continuing down along the backbone the entire pluck may be easily removed. To facilitate cooling, the carcass should be split or sawed down the backbone. In splitting or sawing the carcass be careful to cut near the mid line.

THE LEAF FAT.

While the carcass is still warm remove the leaf or kidney fat in order to facilitate its cooling. To remove the leaf fat, peel it upward

with the fingers, beginning at the bottom. The kidneys, which are in this fat, should be removed. The leaf fat should be spread out on a table to cool, with the thin membrane side turned down. The gut fat should not be mixed with the leaf fat in rendering.

COOLING THE CARCASS.

The carcass should be cooled rapidly after slaughtering, but not allowed to freeze. Select a day when there is chance for cooling the carcass before the surface freezes. The desirable temperature for cooling meat is from 34° to 40° F. In summer it is necessary to have refrigeration. In the fall it is best to kill in the afternoon, allowing the carcass to cool overnight. Hang the carcass in a dark cellar or cool outbuilding where flies can not get to it. Fresh meat absorbs odors very readily; for that reason do not hang the carcass in a freshly painted room or in a room with tar, kerosene, or gasoline.

CUTTING UP A HOG.

A carcass should not be cut up until it has thoroughly cooled. The usual farm method of cutting up a hog is to remove the head, sever the ribs on each side of the backbone, take out the backbone, and divide the carcass into two equal parts. The ribs are taken out before the sides are "blocked." Another method is to split the carcass with a saw or cleaver as near the mid line as possible. Cut each half into four parts, head, shoulder, middle, and hams, as shown in figure 5, right side.

HEAD.

The head is generally removed before the carcass is split into halves. Cut about an inch back of the ears, making a complete circle around the neck. If the cut does not strike the atlas joint, twist the head and it will yield. The fat of the head may be used for lard and the fleshy parts for sausage or headcheese. The jowl is sometimes used for cooking with vegetable greens.

SHOULDER.

Cut off the front foot about 1 inch below the knee. The shoulder cut is made through the third rib at the breastbone and across the fourth. Remove the ribs from the shoulder, also the piece of backbone which is attached. Cut close to the ribs in removing them so as to leave as much meat on the shoulder as possible. These are "shoulder or neck ribs" and make an excellent dish when fried or baked. If only a small quantity of cured meat is desired, the top of the shoulder may be cut off about one-third the distance from the top and parallel to it. The fat of the shoulder top may be used for lard and the lean meat for steak or roasts. It should be trimmed smoothly. In case the shoulders are very large divide them cross-

wise into two parts (see fig. 6). This enables the cure mixture to penetrate more easily and therefore lessens the danger of souring.

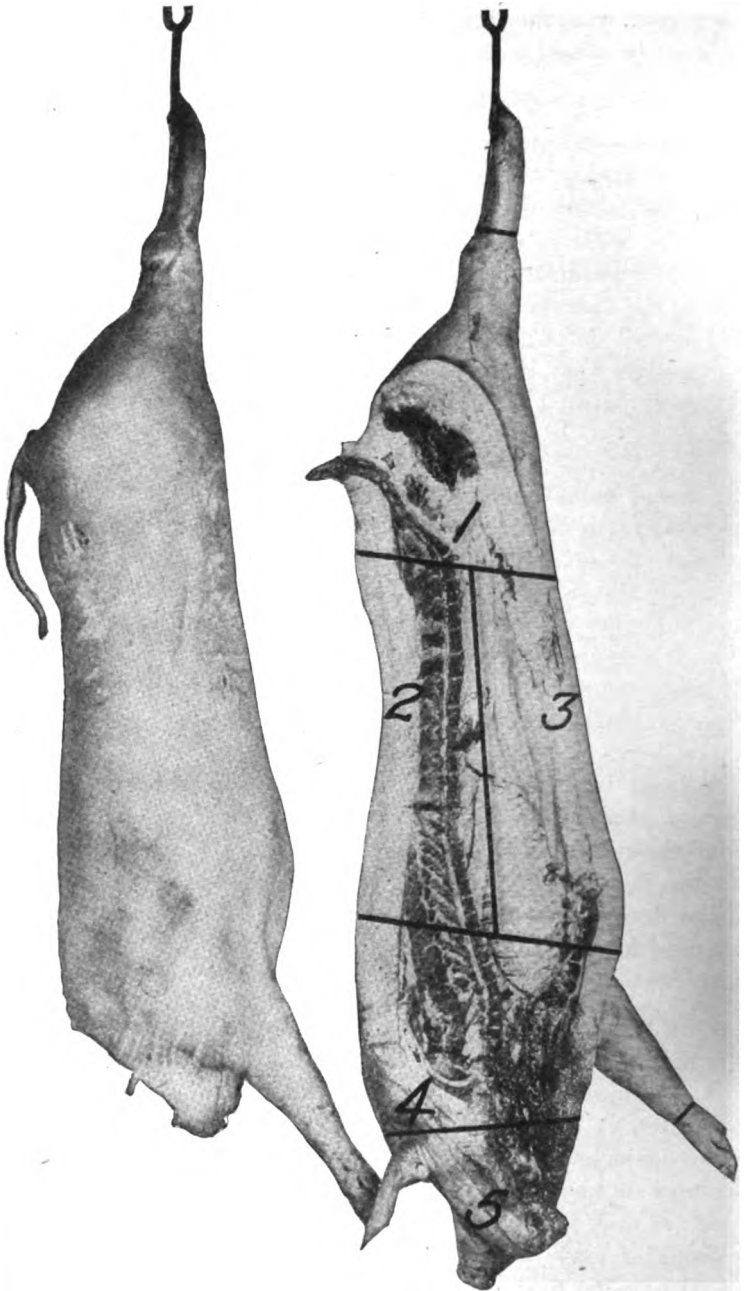


FIG. 5.- Cuts of pork: 1. Ham. 2. Loin. 3. Bacon. 4. Shoulder. 5. Head. The fat trimmings should be used for lard and the lean trimmings for sausage.

MIDDLELING OR BACON.

The ham is removed from the middling by cutting just at the rise in the backbone and at a right angle to the shanks, as shown in figure 5.



FIG. 6.—The shoulder cuts and trimmings.

The loin and fatback are cut off in one piece, parallel with the back just below the tenderloin muscle on the rear part of the middling. Remove the fat on the top of the loin, but do not cut into

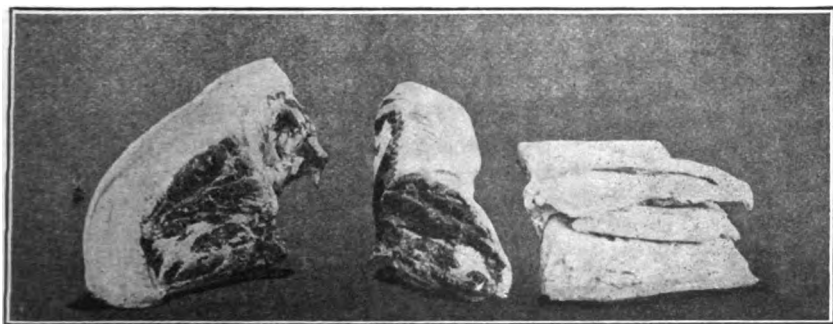


FIG. 7.—Untrimmed loin, trimmed loin, and loin trimmings.

the loin meat. The lean meat is excellent for canning or it may be used for chops or roasts and the fatback for lard. The remainder should then be trimmed for middling or bacon. Remove the ribs, cutting as close to them as possible. If it is a very large side, it may be cut into two pieces. Trim all sides and edges as squarely as possible (fig. 9).

HAM.

Cut off the foot about 1 inch below the hock joint. All rough and hanging pieces of meat should be trimmed from the ham. It should then be trimmed smoothly, exposing as little lean meat as possible, because the curing hardens it (fig. 8). All lean trimmings should be saved for sausage and fat trimmings for lard.



FIG. 8.—Ham and ham trimmings.

The other half of the carcass should be cut up in similar manner.

MEAT TRIMMINGS AND FAT TRIMMINGS.

After the carcass has been cut up and the pieces are trimmed and shaped properly for the curing process there are many pieces of lean meat, fat meat, and fat which can be used for making sausage and lard. The fat should be separated from the lean and used for lard. The meat should be cut into convenient-sized pieces to pass through the grinder.

RENDERING LARD.

The leaf fat makes lard of the best quality. The back strip of the side also makes good lard, as do the trimmings of the ham, shoulder, and neck. Intestinal or gut fat makes an inferior grade and is best rendered by itself. This should be thoroughly washed and left in cold water for several hours before rendering, thus partially eliminat-

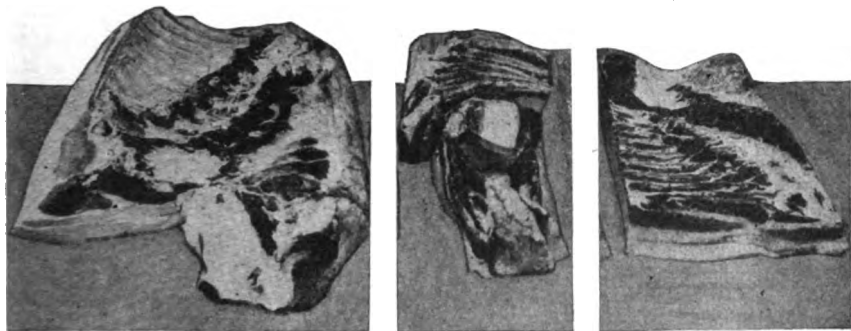


FIG. 9.—A side of bacon and bacon trimmings.

ing the offensive odor. Leaf fat, back strips, and fat trimmings may be rendered together. If the gut fat is included, the lard takes on a very offensive odor.

First, remove all skin and lean meat from the fat trimmings. To do this cut the fat into strips about $1\frac{1}{2}$ inches wide, then place the strip on the table, skin down, and cut the fat from the skin. When a piece of skin large enough to grasp is freed from the fat, take it in the left hand and with the knife held in the right hand inserted between the fat and skin, pull the skin. If the knife is slanted downward slightly, this will

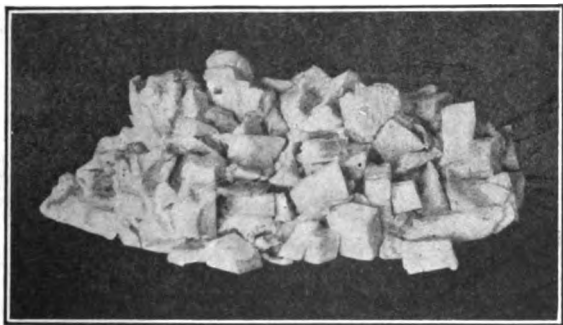


FIG. 10.—Pieces of fat cut for rendering.

easily remove the fat from the skin. The strips of fat should then be cut into pieces 1 or $1\frac{1}{2}$ inches square, making them about equal in size so that they will try out evenly (fig. 10).

Pour into the kettle about a quart of water, then fill it nearly full with fat cuttings. The fat will then heat and bring out the grease without burning. Render the lard over a moderate fire. At the beginning the temperature should be about 160° F., and it should be increased to 240° F. When the cracklings begin to brown, reduce

the temperature to 200° F. or a little more, but not to exceed 212° F., in order to prevent scorching. Frequent stirring is necessary to prevent burning (fig. 11). When the cracklings are thoroughly browned, and light enough to float, the kettle should be removed from the fire. Press the lard from the cracklings. When the lard is removed from the fire allow it to cool a little. Strain it through a

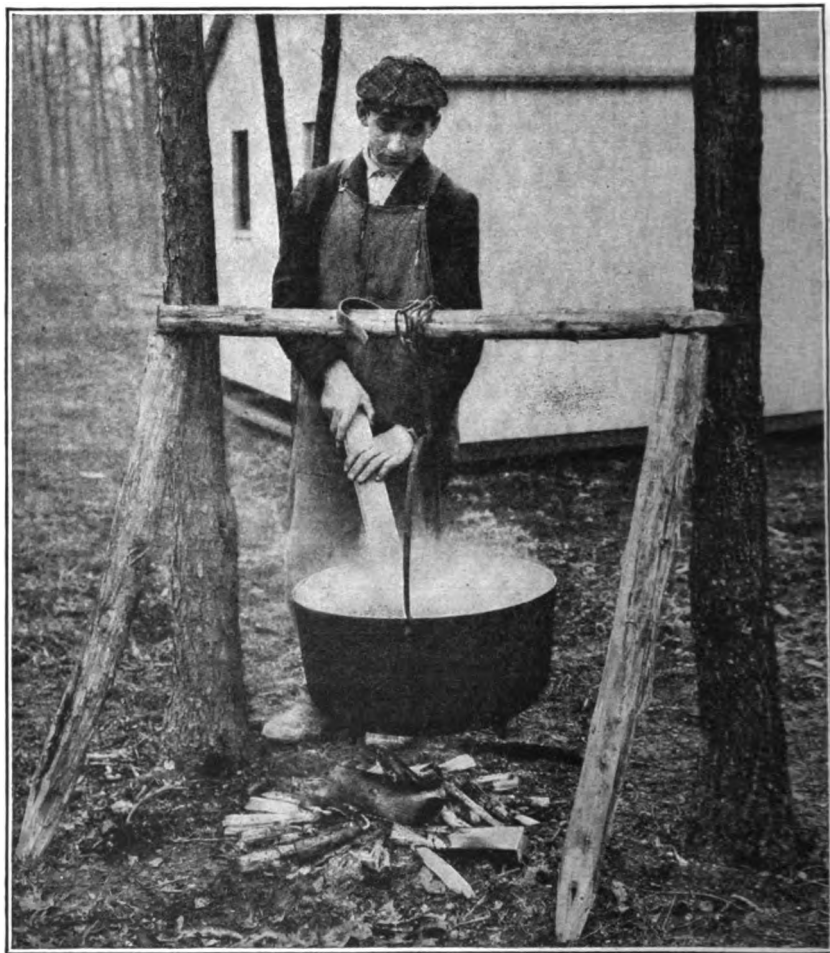


FIG. 11.—A suitable kettle for rendering lard.

muslin cloth into the containers. To aid cooling stir it, which also tends to whiten it and make it smooth.

Lard which is to be kept for a considerable time should be placed in air-tight containers and stored in the cellar or other convenient place away from the light, in order to avoid rancidity. Fruit jars make excellent containers for lard, because they can be completely sealed. Glazed earthenware containers, such as crocks and jars, may

also be used. All containers should be sterilized before filling, and if covers are placed on the crocks or jars, they also should be sterilized before use. Lard stored in air-tight containers away from the light has been found to keep in perfect condition for a number of years.

When removing lard from a container for use, take it off evenly from the surface exposed. Do not dig down into the lard and take out a scoopful, as that leaves a thin coating around the sides of the container, which will become rancid very quickly through the action of the air.

CURING PORK.

The first essential in curing pork is to make sure that the carcass is thoroughly cooled, but meat should never be allowed to freeze either before or during the period of curing.

The proper time to begin curing is when the meat is cool and still fresh, or about 24 to 36 hours after killing.

VESSELS FOR CURING.

A clean, hardwood molasses or sirup barrel is a suitable vessel in which to cure pork. The barrel should be clean and tight so as to prevent leakage. A large stone jar is the best container in which to cure meat, though the initial cost is high; such a container is very easily kept clean. If a barrel is used repeatedly for curing pork, it is necessary to scald it out thoroughly before fresh pork is packed in it.

CURING AGENTS.

Salt, saltpeter, sugar, and molasses are the principal preservatives used in curing pork. The use of borax, boric acid, formalin, salicylic acid, and other chemicals is prohibited in connection with meats and products to which the Federal meat-inspection law is applicable.

Salt when applied alone to meat makes it very hard and dry, because its action draws out the meat juices and hardens the muscle fibers. Saltpeter is used to hasten the curing of the meat. It is more astringent than salt and should be used sparingly. Sugar and molasses soften the muscle fibers and improve the flavor of the meat; hence a combination of salt and sugar makes a good cure.

PLACE FOR CURING.

A cool, well-ventilated cellar, free from rats, is the most desirable place for both brine and dry curing. The smokehouse may also be used for this purpose, but it should be observed that when curing by the dry-salt method special attention should be given to the ventilation to prevent excessive dryness.

Cold-storage and ice plants generally have rooms equipped with partitioned shelves, where farmers may store their meat during the process of curing at an even temperature, which will insure excellent results. This should be beneficial in southern climates, where the weather is warm or subject to sudden change. In localities where such refrigeration facilities have not been established cooperative cold-storage plants conducted by a number of farmers in a community may be found to be a good investment, as plants of that kind may be used also for the purpose of manufacturing ice during the summer and the power may be utilized further in generating electricity for lighting.

DRY CURE COMPARED WITH SWEET-PICKLE OR BRINE CURE.

There are two methods of curing pork—the dry cure and the sweet-pickle or brine cure. The dry cure is preferred, as it is simpler and requires less handling of the meat, as will be observed from the formulas outlined in the following paragraphs. The sweet-pickle or brine cure is not advocated in the southern sections of the country, in view of the uncertain temperatures, the cure being retarded when the temperature ranges above 50° F., causing the meat to spoil. Dry-cured meat improves with age and is better several months after it is smoked. Irrespective of the curing method used, it is advisable before curing to rub the surface of the meat with fine salt and allow it to drain, flesh side down, for from 6 to 12 hours.

DRY-CURED PORK.

Formula No. 1.—For each 100 pounds of meat use—

- 8 pounds salt.
- 2½ pounds molasses or sirup, warmed slightly.
- 2 ounces saltpeter.
- 3 ounces black pepper.
- 2 ounces red pepper.

Mix the ingredients well. Rub the mixture over the meat thoroughly and pack it away in a barrel, box, or on a table. About the third day break the bulk and repack to insure thorough contact with the cure mixture, then allow the meat to remain until the cure is completed. This will take two days in cure for each pound that the individual pieces of meat weigh; for example, a 10-pound ham will take 20 days. After the meat has cured hang it in the smokehouse without washing. (See p. 22 for directions for smoking.) When the meat is packed in tight barrels the liquid formed will aid in curing the heavier pieces of meat, which should be at the bottom.

Some persons attempt to use the foregoing formula without the saltpeter, but the result will not be satisfactory. The saltpeter should by no means be omitted.

SWEET-PICKLE OR BRINE-CURED PORK.

Formula No. 2.—For each 100 pounds of meat use—

- 9 pounds salt.
- 2½ pounds sugar or 4 pounds molasses or sirup.
- 2 ounces saltpeter.
- 4½ gallons water.

If the weather is warm 10 pounds of salt is preferable.

Allow four days for curing each pound of ham or shoulder and three days for each pound of bacon and smaller pieces. For example, a 15-pound ham will take 60 days; a piece of bacon weighing 10 pounds, 30 days.

All the ingredients are placed in the water and thoroughly stirred. The brine mixture should be prepared the day before it is to be used, so that it will be completely dissolved. Place the hams on the bottom of the container, shoulders next, bacon sides and small cuts on top. Cover with boards weighted with stones or bricks, as iron rusts and stains the meat. Pour the pickle in and be sure that it covers the meat thoroughly. In seven days take out all the meat, remove the pickle, replace the meat in the container, weight it down, then cover again with the pickle. Repeat this process every seven days until cure is completed.

If the pickle becomes ropy, take out all the meat and wash it and the container thoroughly. Boil the ropy pickle, or, better, make new pickle. When each piece of meat has received the proper cure, remove it from the pickle and wash in lukewarm water. String it and hang it in the smokehouse. (See p. 22 for directions for smoking.) The temperature of the smokehouse should not exceed 120° F. Smoke the meat until it has a good chestnut color.

CURING SMITHFIELD HAMS.

The following method for producing Smithfield hams has been furnished:

The hams are placed in a large tray of fine salt, then the flesh surface is sprinkled with finely ground saltpeter until they are as white as though covered by a moderate frost, or, say, use 4 to 6 ounces of the powdered saltpeter to each 100 pounds of green hams.

After applying the saltpeter, salt immediately with the fine salt, covering the entire surface well. Then pack the hams in bulk, skin-side down, but in piles not more than 3 feet high. In ordinary weather the hams should remain thus for three days. Then break bulk and resalt with fine salt. The hams thus salted and resalted should now remain in bulk one day for each pound; that is, a 10-pound ham should remain 10 days and in like proportion of time for larger and smaller sizes. When the cure is complete wash

with tepid water until the hams are clean, and after partially drying rub the entire surface with finely ground black pepper. They should then be hung in the smokehouse and the important operation of smoking begun. The smoking should be done very gradually and slowly, extending through 30 or 40 days.

After the hams are cured and smoked they should be re-peppered to guard against vermin and then be bagged. Such hams improve with age and are in perfect condition when 1 year old.

PICKLED PORK.

Fatbacks cut into suitable pieces for curing are generally treated in the following manner: The pieces of meat are packed in a container and a pickle made of the following ingredients is poured over the meat: To 4 gallons of water add 10 pounds of salt and 2 ounces of saltpeter for each 100 pounds of meat.

PICKLED PIGS' FEET.

The feet may be used for pickled pigs' feet or pig's-foot jelly.

In preparing pickled pigs' feet, place them in salt pickle for several days. Then boil them for a varying length of time, depending upon the size of the feet, taking care to remove them from the kettle before the separation of the meat from the bones. Split the feet lengthwise, place them in a jar or other receptacle, and cover with vinegar to which bay leaves, allspice, and whole black pepper have been added.

Pig's-foot jelly is prepared by curing the feet for several days in salt pickle, after which they should be boiled until the meat separates from the bone. Add vinegar, allspice, and pepper, and pack into molds.

MAKING SAUSAGE.

Trimnings and pieces of meat which otherwise might be wasted may be converted into some form of sausage. Sausage making is a trade well worth learning. Often on the farm when animals are butchered for home consumption portions of the carcass are not utilized to the best advantage. A demand for fresh and smoked country sausage always exists, and it is just as important for every farmer to know how to make good sausage as it is to know how to make good hams and bacon.

The only equipment necessary to make sausage is a meat cutter with a stuffer attachment. A knife, cord string, and casings or muslin bags also will be needed. Muslin bags can be made of any size, but the most convenient are 12 inches long by 2 inches in diameter. When sausage is stuffed in muslin bags they should be paraffined after stuffing. Sausage stuffed in muslin bags and paraf-

finer keeps longer and better than in casings. Sausage will keep very well in stone crocks or tin pans if a layer of hot lard or paraffin is poured over the top.

PURE PORK SAUSAGE.

Good pork sausage may be made as follows:

65 pounds fresh lean meat.	2 ounces fine sage.
35 pounds fat.	1 ounce ground nutmeg.
1½ pounds salt.	4 ounces black pepper.

Cut the meat into small pieces, mix and add the spices, and then put through the grinder, using the small plate. After it is well

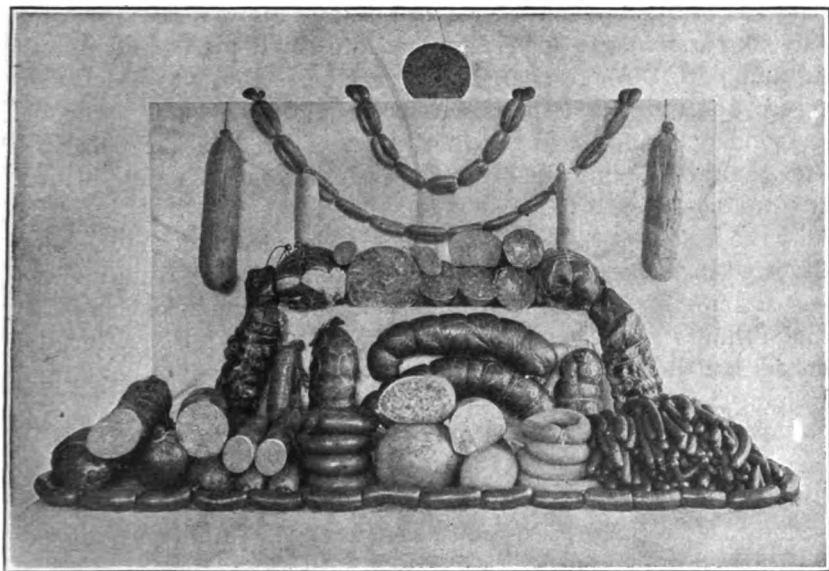


FIG. 12.—A display of various kinds of sausage.

ground, mix thoroughly to be sure that it is uniformly seasoned. No water should be added if the sausage is to be stored away in bulk. If it is to be stuffed in casings a little water may be necessary to soften the meat so that it will slip easily into the casings.

SMOKED OR COUNTRY SAUSAGE.

The following ingredients are used in making smoked or country sausage:

85 pounds lean pork.	1 ounce red pepper.
15 pounds beef.	1 ounce sweet marjoram.
1½ or 2 pounds salt.	1 ounce mace.
4 ounces black pepper.	

Cut the meat into small pieces and sprinkle seasoning over it, then run it through the grinder, using the small plate. Put it away in a

cool place for from 24 to 36 hours, then add a little water and stuff into hog casings and smoke in a very cool smoke until a dark-mahogany color is obtained.

FRANKFURT OR VIENNA SAUSAGE.

Frankfurt or Vienna-style sausage is more popular with the manufacturers and the trade than any other kind. It is made as follows:

70 pounds beef.	2 ounces nutmeg.
30 pounds pork (not too lean).	$\frac{1}{2}$ ounce black pepper.
20 pounds water.	1 or 2 ounces fed pepper.
$1\frac{1}{2}$ or 2 pounds salt.	

Cut the beef into small pieces, salt it, and allow it to cure for 48 hours in a cool place. Cut the pork into small pieces and put the beef and pork through the grinder together. Put into a container and add the water and spices. After it is all mixed put it through the grinder again, using the fine plate. Stuff into sheep casings. After the sausage is stuffed into the casings by means of the thumb and forefinger, press the casing together at about 4-inch intervals. Twist the first link two or three times. The next link made should be twisted in the opposite direction to keep the casing from untwisting. After it is twisted into links, hang it in the smokehouse for about 2 hours at a temperature not to exceed 125° F. After it is smoked, boil it for 5 or 10 minutes; then plunge it into cold water and hang it in a cool place.

BOLOGNA-STYLE SAUSAGE.

Bologna-style sausage is used extensively for lunches on picnics or outings. Its keeping qualities are excellent. The following ingredients are used in making it:

60 pounds cured beef.	2 ounces mace.
40 pounds pork.	1 ounce coriander.
20 pounds water.	4 ounces black pepper.
$1\frac{1}{2}$ or 2 pounds salt.	

Grind the beef and let it cure for 24 hours in a cool place, then grind it very fine.² Put the pork through the grinder, using the medium plate. Then put the beef and pork together into a container and add the spices and water. Mix thoroughly until it takes on a dull color and becomes sticky. Stuff into weasands, large beef casings, or in beef rounds. This sausage can also be stuffed into muslin bags and paraffined. It will keep perfectly prepared in this way. Allow it to hang about 20 minutes in a cool place. Smoke for about 2 hours, or until a good color is obtained, at a temperature not to exceed

² Beef should be ground, salt and seasoning added, and the bulk stored away for from 24 to 48 hours before using it for sausage. Fresh meat stuffed into casings and smoked, invariably spoils.

140° F. After the bologna is smoked it should be cooked, the weasands and rounds about 30 minutes, and the larger bolognas about 1½ hours, at a temperature of 160° F. To tell when bologna is cooked enough, squeeze it in the hand, and if done it will squeak when the pressure is released. Place in cold water for about 30 minutes and then hang it up in a cool place to keep.

BLOOD SAUSAGE.

Blood sausage is made of the following ingredients:

25 pounds cured back fat or shoulder fat.	1 pound salt.
7 pounds cured fat skins.	½ ounce white pepper.
6 pounds blood.	1 ounce sweet marjoram.
½ pound onions.	½ ounce cloves.

Cook the fat, which has been dry-cured or sweet-pickled, for about 1 hour and the skins 2 hours at a temperature of 200° F. When cooked put through grinder, using small or medium plate. Put into a container, add blood and seasoning, and mix thoroughly. Stuff into large beef casings and boil, in the same water that the meat was cooked in, until the sausage floats. Dip the sausage into cold water and hang away to cool.

HEADCHEESE.

The head is frequently used for making headcheese. The head should be shaved clean, the snout skinned and nostrils cut off just in front of the eyes. Cut out the eyes and eardrums. The fattest part should be used for lard. When the head is cleaned, soak it in water for some time to extract the blood and dirt. After the head is thoroughly cleaned cover it with water and boil until the meat separates from the bones. Tongues may be cooked with the head. When thoroughly cooked take out the meat, saving the liquor for future use. Chop the meat up fine. Season with the following for every 50 pounds of meat:

2 gallons of the liquor.	1 ounce red pepper.
1½ pounds salt.	4 ounces ground cloves.
3 ounces black pepper.	

All should be mixed thoroughly so that proper seasoning is obtained. If casings are available, stuff the mixture into large beef casings. A hog stomach, after it is thoroughly cleaned, may be used. If the meat is stuffed into casings it should be boiled again in the same liquor in which the meat was boiled. The meat in the casings should be boiled until it floats, then placed in cold water for a short time. Store it away in a clean, cool place on a shelf or table. Place a board over the meat in the casings with a weight on top in order to hold the shape and to prevent the moisture from collecting in one

spot. If there are no casings available in which to stuff the meat it should be kept in shallow pans.

LIVER PUDDING.

All the odds and ends of trimmings not used for sausage, resulting from cutting up the hog carcass, may be used in making liver pudding. The head, if used, should be cleaned as previously described under "Headcheese." The jowl should be cut off and salted down. The head, liver cut into slices and some beef or veal, if any is at hand, should be put into a kettle and boiled. The skin which has been cut from the fat also can be boiled with this meat. The skin will cook more quickly than the meat, so that it should be put into a cloth sack and removed when thoroughly cooked. Livers also cook in a very short time and should be removed. The meat should cook until it falls from the bones. All the meat except the skin and liver should be ground, using the smaller grinder plate. To 40 pounds of meat add about 1 gallon soup (the broth the meat was cooked in) and the following seasoning:

1½ pounds salt.
3 ounces sweet marjoram.
1 ounce allspice.

1 ounce black pepper.
Garlic or onion, if desired.

The seasoning should be worked into the meat. This finished product can be put into jars covered with paraffin or stuffed into beef rounds. When stuffed into casings it should be cooked until it floats in the same water in which the meat was cooked. Then place in cold water until it is thoroughly cooled.

SUMMER SAUSAGE.

The following ingredients are used to make summer sausage:

25 pounds cured beef free from
sinews.
15 pounds pork trimmings.

6 ounces white pepper.
1 ounce whole black pepper.
1 ounce whole mustard seed.

This sausage can be made in cold weather only. All the meat is put through the grinder and spices added. No salt is needed, the cured beef being salty enough. Mix it all thoroughly until it is evenly seasoned. Spread it out in a cool place and leave it for from 36 to 40 hours, then stuff it into hog-bung casings and let hang overnight. Smoke over very cool smoke for several days. This sausage can be kept in a dry place the year round. If it gets moldy, simply wipe the mold off.

SMOKING CURED MEAT.

The process of smoking helps to preserve the meat. Smoking also gives a desirable flavor to the meat if it is smoked properly and with the right kind of fuel.

THE SMOKEHOUSE.

The smokehouse can be made of any size and of the kind of material suitable to the demands of the owner. If a very small quantity of meat is to be smoked once a year, a barrel or a box (fig. 13) will answer. On the other hand, if a considerable quantity of meat is smoked and the house is to be permanent, it should be built of brick, concrete, or stone to be fireproof (fig. 14). A small building can be used if care is taken to confine the fire in an iron kettle to the center of the room. The safest method is to construct a fire pit outside the house and pipe the smoke into the house. The pipe running from the pit to the house should be buried to prevent crushing.

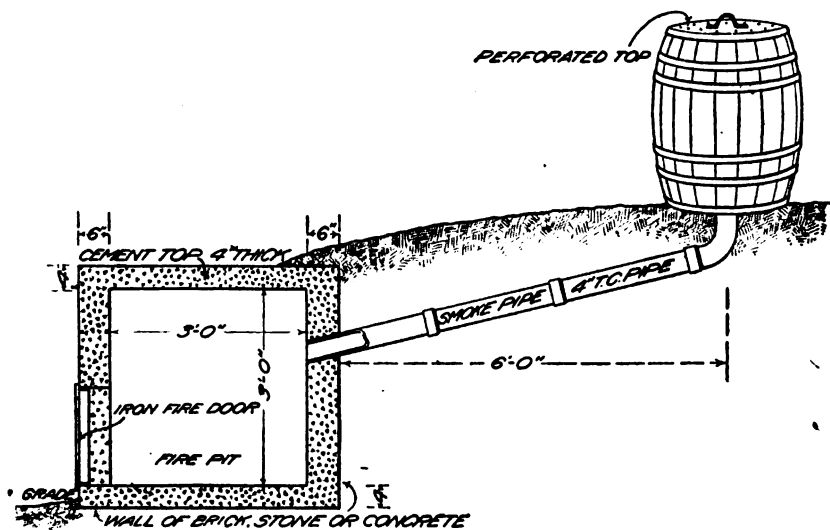


FIG. 13.—A type of smokehouse that can be constructed quickly and cheaply.

A smokehouse, 6 by 8 feet, 14 feet high, will give best results for general farm use. Ventilation should be provided to carry off the warm air and prevent overheating the meat. Small openings under the eaves or a chimney in the roof will control ventilation. If arrangements can not be made to have a fire pit outside the house, it should be built on the floor and a metal sheet constructed to shield the meat. If the meat is hung 6 or 7 feet above the fire, the shield will not be necessary, as at that height the meat will get the benefit of the thick smoke and still hang beyond the reach of the flame.

THE FUEL.

Green hickory or maple wood is the best fuel for smoking. Hard wood is preferable to soft wood. Resinous woods should never be used, as they give an objectionable flavor to the meat. Corncobs may be used, but they deposit carbon on the meat, giving it a dirty appearance.

SMOKING.

Meats which have been cured by the dry-cure method for the proper length of time are ready for smoking. Meats which have been cured by the sweet-pickle or brine method should be removed from the pickle and soaked for half an hour in clean water. If meat has overcured by remaining in pickle longer than the allotted time, soak for half an hour as recommended and three minutes extra for each day overtime for which it has remained in the pickle. Such meat



FIG. 14.—A farm smokehouse, fireproof and fairly tight.

has become pickle-soaked and its quality impaired. After soaking, rinse, fasten the strings securely, and hang in the smokehouse.

Hang the pieces so that they do not touch. This allows proper coloration of the meat to occur and gives good opportunity for circulation of the smoke. Keep the fire going continuously if smoking is to be completed in one operation, holding the temperature as even as possible and not allowing it to go beyond 120° F. From 36 to 48 hours may produce a satisfactory color, but if it is intended to keep the meat until well aged, longer and slower smoking is desirable.

(Some of the old, family methods call for light, intermittent smoking throughout six weeks.)

During warm weather it is better to start a fire every other day rather than heat the meat too much. In the winter, however, if the fire is not kept going, the meat may cool and the smoke will not penetrate properly. As soon as the meat is thoroughly smoked, open the doors and ventilator in order to cool the meat. When the meat is smoked it may hang in the smokehouse, but it is better that it should be wrapped and sacked.



FIG. 15.—Meat hanging in a smokehouse.

The use of "liquid smoke" has become more or less generally practiced in various sections of the country. The Federal meat-inspection regulations prohibit its use in packing houses where inspection is maintained. Meat prepared by farmers on the farms is prohibited by the above-mentioned regulations from interstate shipment if it has been subjected to liquid-smoke treatment.

STORING SMOKED MEATS.

After it is hard and firm, smoked meat may be wrapped in heavy paper and put into muslin sacks. It is very important that the top of the sack be tied properly to keep insects out. Before the hams or strips of bacon are placed in the sacks, remove the strings from the hams. There is a great tendency to use the same strings to hang

up the meat after it is sacked as were used to hang it while smoking. It is impossible to tie the top of the sack and make it insect proof if a string from the meat passes through the paper and sticks out at the top. In tying the top of the sack make a double wrap before tying a knot, which will prevent the entrance of any insects. Each sack may then be painted with yellow wash, used to protect them, and hung up for future use. Never stack hams and bacons in a pile after yellow wash has been applied.

RECIPE FOR YELLOW WASH.

For 100 pounds hams or bacon use—

3 pounds barium sulphate.
1 ounce glue (dry).

1½ ounces chrome yellow.
6 ounces flour.

Half fill a pail with water and mix in the flour, breaking up all lumps thoroughly. Mix the chrome yellow in a quart of water in a separate vessel, add the glue and pour both into the flour-and-water mixture. Bring the whole to a boil and add the barium sulphate slowly, stirring constantly. Make the wash the day before it is required. Stir it frequently while using, and apply with a brush.

DIRECTIONS FOR COOKING AN OLD HAM.

Soak several hours, thoroughly remove all mold and loose pieces, and rinse well.

Cover with cold water, add two tablespoonfuls of vinegar, one-half cup brown sugar, four cloves and one bay leaf, and heat to boiling. (The amount of cloves and bay leaf may be increased if desired, especially for larger hams.)

Reduce the heat to a constant simmer and allow to cook at this temperature at the rate of 20 minutes for each pound weight.

Remove from the fire, but keep the ham in the liquor in which it was cooked, until cold; then remove from the container and allow to drain.

Take off the skin, score the fat in inch blocks, and cover with a coating of brown sugar and crumbs. Stick with cloves 1 inch apart.

Bake in a slow oven until nicely browned, basting at intervals with one-half cup of water and one tablespoonful of vinegar.

SHIPPER'S CERTIFICATE.

Farmers who ship their cured meats must comply with official State and Federal regulations. Below appears a sample shipper's certificate such as must be used in interstate shipments of uninspected meat or meat food products which are from animals slaugh-

tered by the farmer on the farm. In providing blank certificates for the purpose this sample should be followed. In size it should be $5\frac{1}{4}$ by 8 inches.

SHIPPER'S CERTIFICATE.

Date _____, 19__

Name of carrier _____

Shipper _____

Point of shipment _____

Consignee _____

Destination _____

I hereby certify that the following-described uninspected meat or meat food products are from animals slaughtered by a farmer on the farm, and are offered for transportation in interstate or foreign commerce as exempted from inspection according to the act of Congress of June 30, 1906, and at this date they are sound, healthful, wholesome, and fit for human food, and contain no preservative or coloring matter or other substance prohibited by the regulations of the Secretary of Agriculture governing meat inspection.

Amount and weight.

Kind of product _____

(Signature of shipper.)

(Address of shipper.)

Two copies of this form to be presented to the common carrier with each shipment.

ECONOMIC SUGGESTIONS ON KILLING AND CURING.

Cleanliness is the most important factor in butchering and in curing meats. Meat very easily becomes tainted.

Save all pieces of meat for sausage. There are many ways of converting it into a palatable product.

All waste fat, trimmings, and skin should be rendered and the product used to make soap.

Bones should be crushed or ground for chicken feed.

Never put meat in to cure before the animal heat is out of it.

Always pack meat skin-side down when in the curing process, except the top layer in a brine cure, which should be turned flesh-side down.

Keep close watch of the brine, and if it becomes "ropy," change it.

Do not forget to turn or change meat several times during the curing process.

The fat of dry-cured meat sometimes becomes yellow, but that does not make it unwholesome.

It takes more time to smoke dry-cured than brine-cured pork.

Slow smoking is much better than rapid smoking, and there is less chance of causing the meat to drip.

If meat becomes moldy, brush off the mold with a stiff brush or trim the moldy parts off with a knife.

Be sure that meat is thoroughly cooled before sacking.

The seasoning of sausage is generally governed by taste.

Fresh sausage can be kept under a covering of lard for a number of days.

HOME CANNING OF PORK AND PORK PRODUCTS.

While the curing of meat with salt, followed by smoking, is in universal use and has been known as far back as records go, the canning of meats, although relatively new, has become one of the most important methods of food preservation.

This method has been made practicable by the introduction of small steam-pressure cookers, suitable for use in the home, and which make the process much more safe. By their use all kinds of home products, whether animal or vegetable, can be preserved successfully in an attractive, palatable, and economical way. On the farm, where often fresh meat can not be bought readily, the value to the housekeeper of such a supply of provisions always available can not be overestimated.

STEAM-PRESSURE COOKER OR CANNER NECESSARY.

For the successful canning of meats a steam-pressure cooker (fig. 16) is necessary, as only by its use can the required temperature for properly sterilizing meats be obtained. The needed temperature is 250° F., equivalent to steam pressure at 15 pounds per square inch.

The use of the pressure cooker in the household is not confined to canning, for with it daily meals can be prepared in much less time than by ordinary methods of cooking and its cost saved many times over.³

Canning meat without steam pressure is not safe on account of the danger of imperfect sterilization and consequent spoilage.

Meat can be canned in either tin or glass. With glass the very best quality of jar rubbers must be used, as meats will not keep if the rubber ring is cracked or damaged, so that air, and with it bacteria, can enter.

³ Instructions for cooking meals in steam-pressure cooker can be had from Office of Extension Work, South, States Relations Service, United States Department of Agriculture, Washington, D. C.

HOW TO USE THE STEAM-PRESSURE COOKER OR CANNER.

Pressure cookers should be of standard quality, constructed to maintain uniformly at least 15 or 20 pounds of pressure and be tested for considerably higher pressures to insure safety to the operator. The home steam-pressure cooker consists of a kettlelike receptacle with a lid that can be securely fastened, making a steam-tight joint. It is fitted with a gauge recording the steam pressure per square inch, generally expressed in pounds. A thermometer giving the inside temperature is sometimes attached. There must be a safety

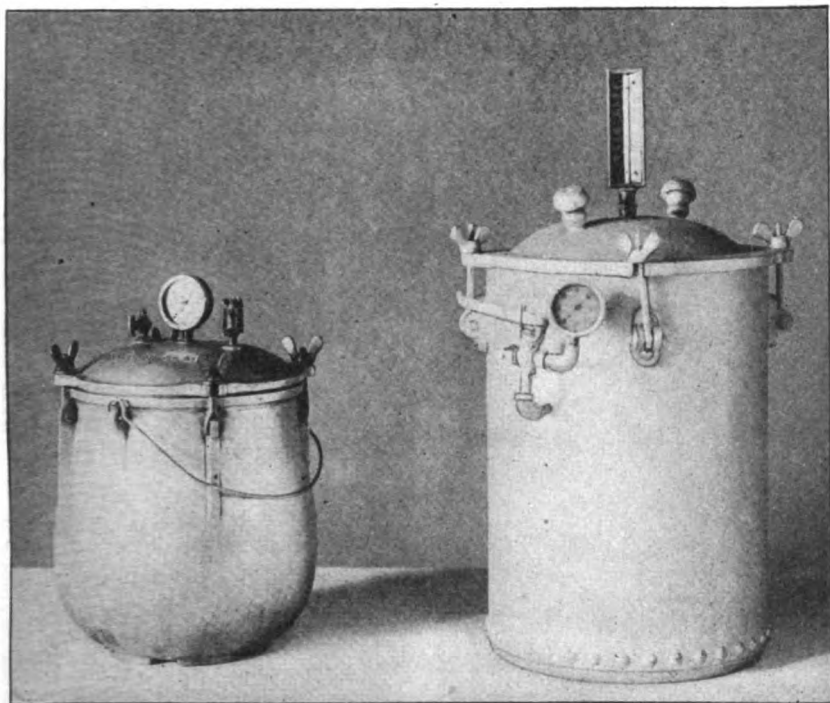


FIG. 16.—Two types of pressure cookers in common use.

valve for the escape of steam as soon as the pressure reaches a certain number of pounds per square inch. In some cookers this safety valve is adjustable as to the pressure reached before it “blows off.” There must also be a pet cock through which air and steam can be let out, thus reducing the pressure to zero before opening the cooker; otherwise the person attempting to unfasten the cover may be seriously scalded.

When the women do the canning, and if it is desired also to use the pressure cooker in the preparation of daily meals, an aluminum pressure cooker may be preferred on account of not being so heavy to lift as those made of boiler steel.

PREPARATION OF PORK FOR CANNING.

Handle all meats in a cleanly manner. As soon as the animal heat has disappeared the meat may be prepared for canning. It should always be cooked first—roasted, fried, broiled, baked, or stewed—just as though for immediate serving, so that the flavor can be largely retained (fig. 17). If raw meat is packed, the time for sterilization will have to be prolonged considerably and the can will contain boiled or steam-cooked meat. On the other hand, if the meat is roasted,

fried, or otherwise prepared and hot gravy stock is added, the time required for sterilization will not be so long, and when the can is opened it will contain the roasted, fried, or otherwise prepared meat with the flavor of the freshly cooked product.

Season the meat according to individual taste and cook it thoroughly. Whatever method is chosen, the meat should be cooked tender and not be red in the center.

From the hog carcass the head may be cleaned and used for headcheese and canned; the brains may be soaked in salted water to remove any blood, then fried or otherwise prepared, and canned. The tongue may be lightly salted, boiled, and canned, with a little meat

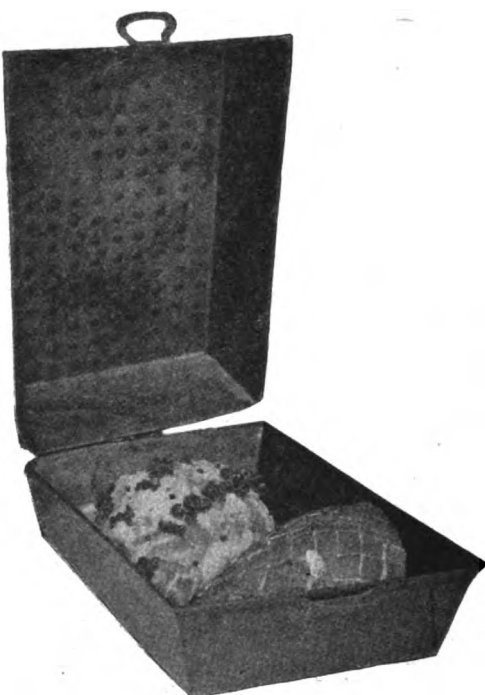


FIG. 17.—Hams in pan ready for roasting. Results are more satisfactory when meat is cooked before canning. Cooked meats improve in the processing, while raw meats become less attractive after processing and standing in storage.

jelly added. The cleaned snout may be boiled, pickled, and canned. The feet, after scalding and thorough cleaning, may be boiled, pickled, and canned. The liver may be soaked in salted water and cleaned carefully; then, after the large veins have been removed, it should be sliced or diced and fried, used for liver sausage, or for liver paste, and canned. The kidneys, having been split open and the little sac in the center removed, should be soaked in several changes of salted water, sliced, and fried, or cut into cubes, stewed, and then canned. The large intestines may be cleaned, scalded, scraped, soaked in several changes of salted water, made into chitterlings, fried or boiled, and canned.

The heart should be cleaned from blood clots, the coarser veins removed, sliced, and made into goulash or spiced heart, or it may be sliced or diced, fried, and then canned. After the lard is rendered the remaining cracklings may be canned, if desired, for crackling bread. The clean skin, cut from the fat used for lard, should be soaked in several changes of cold water, then with just water enough added to cover the skin, cooked for one hour at 10 pounds' pressure. The liquid should then be strained through a double layer of cheesecloth and allowed to cool. When cold the grease can be easily removed from the top and the resulting stock will be thick enough to jelly. It can be reheated and canned like soup and later be used as gelatin for puddings, etc., or it can be used as addition to soups and gravies. The thoroughly boiled skin can be chopped up and mixed with other meat scraps for use in making scrapple or similar dishes.

The bones cut from the fresh meat or from the roasted meat may be utilized for soup stock, although they will not give so much or so rich a soup as that made from beef. The soup stock may be canned. The hams, shoulders, tenderloin, backbone, and spareribs may be roasted, sliced, and packed in cans. (The bones should be removed before canning.) Add hot gravy stock to fill all spaces between the meat pieces. Seal and process. Sausage, made from pork, may be put into casings or made into little cakes, fried and canned. The side meat and fatback may be cured or salted and kept in this way. If the cured bacon or side meat does not keep well through the summer, as sometimes happens in the warmer parts of the country, it may be sliced about one-fourth inch thick, dipped in beaten eggs, and fried to a nice brown color, then packed in cans and processed like other cooked meat.

In some places the blood of the butchered hog is used as food. The blood is first beaten with an egg beater or mayonnaise beater as soon as taken from the butchered animal. It is then strained and mixed with barley or hominy grit, a little finely diced fat pork, some milk, raisins cleaned and scalded, sugar, and spices. It is then put into well-cleaned casings until half full, after which the casings are tied or sewed at the ends and slowly boiled in plenty of water for 1½ hours. The blood may also be made into blood pudding. Either the blood sausage or pudding may be canned.

Thus every part of the hog suitable for human food may be saved and canned; the by-products, which too often are wasted in ordinary farm butchering, may more than pay for the extra labor and the containers needed for canning all the animal

CONTAINERS.

Some people prefer to use glass jars for containers, although tin cans are used in many homes, especially in the Southern States. If

glass jars requiring rubber rings are used the highest quality of rings should be procured. With hermetic-seal jars, be sure that the sealing composition on the cap is unbroken. For some jars it is necessary to use a special machine to put the cover on and seal the jar.

CANNING IN TIN CANS.

There are two types of tin cans in general use, the "cap-and-hole" can and the "sanitary" can. Either of these may be had as plain tin cans or inside-lacquered tin cans. If an acid, like vinegar, has been used in the preparation of the meat to be canned, the inside-lacquered can should be used.

For sealing the cap-and-hole can it is necessary to use a capping steel and a tipping copper. The capping steel must correspond in size to the hole in the can and should fit the cap to be used. A suitable apparatus for heating these irons is needed, and some solder and flux must also be provided.

For the sanitary cans it is necessary to have a mechanical sealer (for home use a hand sealer may be used) by which the whole top is put on in one operation.

To make flux.—Put some commercial muriatic acid into a glass or crockery vessel (a metal container will not do), add strips of sheet zinc (old zinc jar tops from which the glass lining has been removed will do) until no more can be dissolved. Add to this an equal quantity of water and strain through a piece of muslin. This is called flux and should be used with care. When canning, have some flux in a saucer or other container in which to clean the soldering tools. Keep separately in a glass bottle, properly labeled, the quantity which will be needed for sealing the cans.

Capping steel and copper.—Capping steel and copper should be kept coated with solder in order to make the solder flow evenly when sealing. It may be necessary to clean them with coarse sandpaper or even with a file, but care must be taken to see that the edges are kept true. For coating the steel and copper with solder prepare a handful of powdered sal ammoniac mixed with a few pieces of solder and put into a can. Heat the already smoothed capping steel or tipping copper until almost red hot, dip into the flux and then into the sal ammoniac and solder, turning it about and rubbing until bright and well coated with solder, then dip in the flux again.

Filling the cans.—Tin cans must be washed clean in warm water, rinsed, and then with the caps immersed from 10 to 15 minutes in boiling water to remove all dirt or chemicals that may be clinging to the tin. Remove from the water and drain. Never use rusty cans. If sanitary cans are used, the tops must not be put into water, but

should be wiped with a damp cloth just before putting them on the cans and sealing them.

Cut the meat into sizes according to can openings and pack in the cans (fig. 18), filling them within one-half an inch of the top, then pour in boiling hot gravy to fill all spaces between the slices of meat (fig. 19). Do not fill can entirely full, but leave from one-fourth to one-half inch of space at the top of the can. If there is not gravy enough, boiling water or soup stock may be added. Wipe the can top absolutely clean, and especially the grooves around the opening, which must be entirely free from grease. It is best to use a small piece of cloth dipped in boiling water for removing the grease. Wipe dry with a clean cloth.

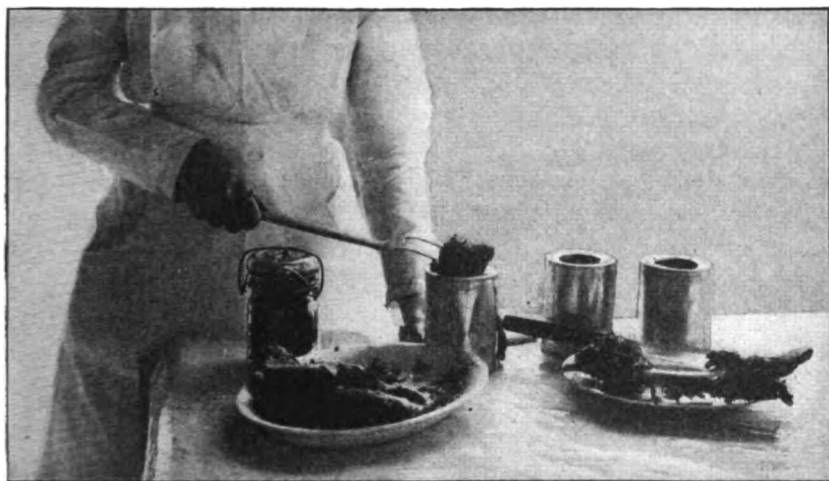


FIG. 18.—Packing meat in cans.

Sealing the caps in place.—Wipe the caps and place them on the cans. Apply flux carefully around the edge of cap in the groove with a small brush or a little mop made by tying a small piece of cloth around a small stick. The flux is used to make the solder adhere to the tin. Apply the clean, hot, capping steel, holding the cap in place with the center rod. As the steel is lowered turn steadily until the solder flows, hold the rod firmly and lift the steel with a sudden twist to swing the melted solder around the groove evenly. Keep the center rod on the cap until the solder sets, which will take only a few seconds.

Exhausting.—Exhausting is driving out the surplus air before completely sealing the can. This is done to prevent possible swelling of the can from the expansion of the air, which might cause it to be taken for a "swell" indicating spoilage due to bacterial action. Furthermore, the presence of air may cause the canned material to

act on the tin and produce salts of tin, which are objectionable from the standpoint of health. If cold meat is placed in the cans, it will always be necessary to exhaust. Place the cans in a wire tray and lower into boiling water to within 1 inch of the top for from 5 to 8 minutes, or just long enough to cause the contents of the can to be heated to 180° F. Exhausting is not necessary, however, if meat is placed hot in cans and boiling gravy added, as the steam from the hot gravy will drive out the air, and the cans should then be sealed at once. When sanitary cans are used the exhausting is done before the top is put on.

Tipping.—Close the small hole in the cap immediately after exhausting or, if filled with hot meat and gravy, immediately after capping. Apply flux as for capping and use a little wire solder (bar

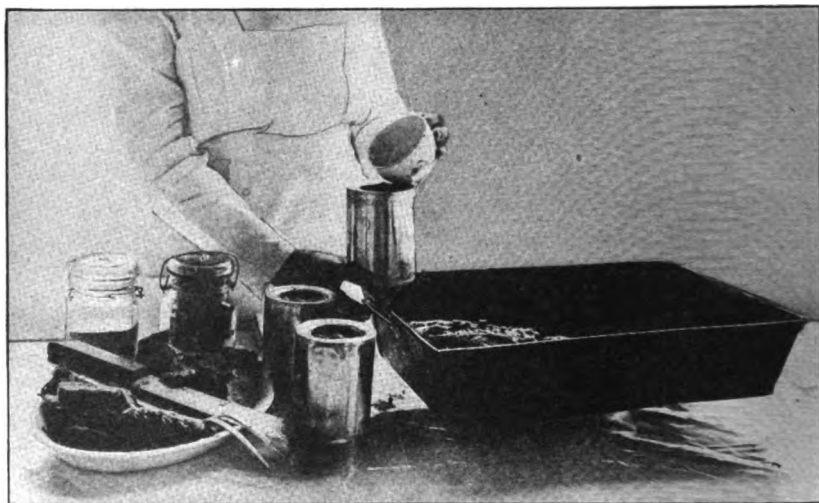


FIG. 19.—Adding gravy to meat in cans.

solder can be used in case the wire solder is not at hand). Hold the solder with the left hand near the hole and barely touch with the hot copper after it has been dipped in the flux, so that only a bead will drop and cover the hole.

Testing for leaks.—As it is essential that the soldering shall completely seal the cans, it is necessary to test the cans before processing (sterilizing) in order to be sure there are no leaks. If the cans have been filled too full or a piece of meat touches the top, it is almost impossible to seal effectively, and little pinholes will be formed in the melted solder. The center rod of the capping steel should never be so pointed that it closes the little venthole entirely when sealing a can containing hot liquid, because the steam formed is liable to escape through the melted solder and thus cause pinholes. Test by submerging the cans in boiling water. If little air bubbles come

through, there are leaks and the can must be resoldered before processing.

Processing.—Processing is the sterilizing of the cans after sealing. Pour boiling water into the steam-pressure cooker until it rises nearly to the level of the rack, but not over it (generally to a depth of from 1 to 1½ inches in the small home pressure cookers). Place the cooker over the fire so that the water will boil vigorously, put the cans to be sterilized into the crate that is furnished with the cooker (or place directly on the rack in the canner), lower this into cooker, put the cover on, and screw down the clamps so that the cover is steam tight. Leave the pet cock open until steam escapes, then partly close, so that only a very small amount of steam escapes. If the safety valve is adjustable, adjust it to “blow off” at the pressure desired, generally 15 pounds at least. Raise the temperature by means of a quick fire until the gauge on the cover of the retort shows 15 pounds of steam pressure. Count time (in accordance with the recipes given later) from the moment this pressure has been reached, which is equal to a temperature of 250° F. This temperature kills the spores of all varieties of bacteria that are destructive to canned meats. A lower fire will now keep the heat up. Keep the temperature uniform at 250° F., or 15 pounds’ pressure, until the time for processing is up; then before unfastening the clamps that hold the cover down open the pet cock or safety valve to let all steam escape. When the gauge shows no pressure, unfasten the clamps, take off the cover, and lift out the cans. The cans are now sterilized. Test for leaks by one of the several methods used for this purpose. For instance, while the cans are hot place them on the floor and tap each one with a little stick. A tight can will give a clear, ringing metallic sound; a leaky can a dull sound. If leaks are found, the cans must be resoldered and again processed. Immerse the sealed cans in cold water to cool quickly and stop the cooking.

CANNING IN GLASS JARS.

For canning in glass the jars are washed clean and put into cold water in a vessel with a false bottom of slatted wood, heated to the boiling point, and kept boiling from 10 to 15 minutes. Then fill (within one-half inch of top) with meat and gravy in just the same way as in the case of tin cans. Adjust the rubber and put the lid in place. If screw-top jars are used, put the top in place but do not screw it down tight (leave about half a turn loose). For glass-top jars, adjust the rubber and glass top. See that the spring is not too loose. Put the wire clamp over the top, but do not press down the spring. For glass tops fastened with a screw ring, fasten the top in position but do not make perfectly tight. When hermetic-seal cans are used, seal as with other jars. Adjust the metal cap, which has a

sealing composition on the inside of the lid (be sure that the sealing composition is even all around the lid, as a leak will appear if the composition is broken in places). Adjust the clamp to hold the lid in place and put into the canner.

Exhausting is not necessary with glass jars, except when they are sealed by a special machine before being processed, as the heating will force the excess air out around the lid. When glass jars are processed the cooker should not be heated so high that steam "blows off" through the safety valve, since this will cause a difference in pressure between the steam on the outside of the jar and that inside the jar, resulting in a part of the contents being forced out or the rubber being pushed out of place. The temperature, of course, must be high enough to sterilize the contents, which, for meats, is equivalent to not less than 15 pounds of steam pressure. At the end of the period of sterilization do not let the steam escape from the cooker, but turn out the fire or lift the vessel from the fire and let it cool until the steam gauge shows that there is no more pressure. Then open the pet cock, unfasten the clamps, remove the cover, and lift out the jars carefully, avoiding any draft, as cold air striking them is likely to cause breakage. Seal immediately by fastening the lid or pressing down the wire springs (the hermetic-seal jar does not need any attention), and allow to cool in a place free from draft. When cold, test for leaks. If any are found the products will have to be resterilized at the temperature and for the time given for regular sterilization. The rubber may also have to be changed before resterilization.

RECIPES FOR CANNING PORK.⁴

The following recipes are given to show how pork products can be prepared and canned in the home. The recipes are merely guides and may be changed to suit the individual taste. The time and temperature given for the processing period, however, should not be changed, as any reduction in either may result in insufficient sterilization and consequent spoilage of the product. It is also *necessary that nothing but absolutely fresh and cleanly handled meats be used.*

In these recipes the time is given for tin cans. Pint glass jars require the same time for processing as the No. 2 tin cans, and quart jars the same time as the No. 3 tin cans.

ROAST PORK.

Select a piece of pork for roasting—generally the ham, shoulder, or loin—scrape skin clean, and wipe with a damp cloth. If the ham

⁴ For information on canning beef, poultry, fish, etc., write to the Office of Extension Work, South, States Relations Service, Washington, D. C., for Circular "A" 92, "Home Canning of Meats and Sea Foods with the Steam Pressure Canner."

is used and skin is left on, cut with point of knife just through skin so as to dice skin, and trim with some cloves and little tufts or parsley (if desired). Salt and pepper to taste should be sprinkled over the ham. For a ham weighing 8 to 10 pounds use 1 to 2 tablespoons of salt and from one-half to 1 teaspoon of pepper. Heat in a roasting pan from 2 to 3 tablespoons of grease. When hot put in the roast and sear quickly all over to seal the pores and prevent loss of the juice of the meat. Add 2 small turnips to the roasting pan and one-half to 1 cup of boiling water. Leave skin-side up (do not turn) and baste frequently.

If skin and fat are removed from ham before roasting, lard with narrow strips of larding pork, alternating with rows of little tufts of parsley. Add one small turnip, one small root of celeriac, a few

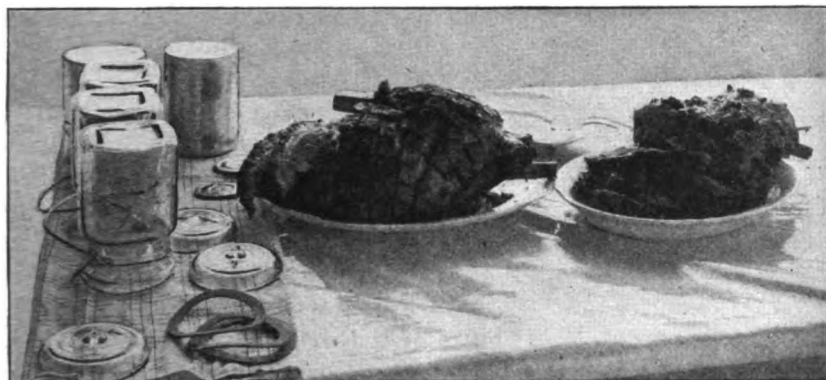


FIG. 20.—Cooked hams ready to be canned.

cloves, and five or six whole peppercorns to roasting pan. Meat may be rubbed with cloves of garlic if desired. Season as in recipe above. Baste frequently.

When cooked through and nicely browned, slice and pack in cans to within one-half inch of top of can. Add the gravy from the roasting pan, with boiling water or soup stock added, so that it barely covers the meat. (There must be at least one-fourth inch space between gravy and top of can.) Cap (exhaust 5 minutes if meat and gravy have cooled; if cold, exhaust 10 minutes; if hot, exhausting is not necessary), tip (seal sanitary cans in machine), and process in steam-pressure cooker as follows:

- No. 1 cans, 40 minutes at 250° F., or 15 pounds of steam pressure.
- No. 2 cans, 45 or 50 minutes at 250° F., or 15 pounds of steam pressure.
- No. 3 cans, 55 or 60 minutes at 250° F., or 15 pounds of steam pressure.

In case meat is fat, time for processing must be prolonged 10 minutes. Backbone may be roasted in a similar way; cut meat from bones and can as already stated.

SPARERIBS.

Roast the spareribs in the usual way, seasoning to taste. Cook until done, browning them nicely. With a sharp knife cut down the inside of each rib, remove the rib bone, and cut the meat into pieces that can pass through the can opening. Make gravy stock by adding water to the pan grease. Pack meat in cans and add the boiling hot gravy stock to within one-half inch of top of can. Cap, tip (seal sanitary cans), and process as follows:

No. 2 cans, 45 minutes at 250° F., or 15 pounds of steam pressure.

No. 3 cans, 60 minutes at 250° F., or 15 pounds of steam pressure.

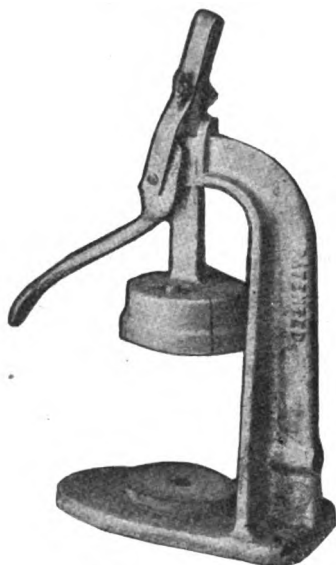


FIG. 21.—A common type of jar sealer.

Spareribs may also be broken in the center with a cleaver or an ax (do not cut apart), folded together, and the opening between the ribs filled with pared, sliced apples and a few washed and soaked prunes. Then tie or sew together at edge, season to taste, and roast until done. Cut in suitable pieces and pack in cans with part of the cooked apples and prunes.

Add gravy stock, boiling hot from the roasting pan. Seal and process as above if bones are removed. If bones are left in, process as follows:

No. 2 cans, 75 minutes at 250° F., or 15 pounds of steam pressure.

No. 3 cans, 90 minutes at 250° F., or 15 pounds of steam pressure.

PORK TENDERLOIN.

The tenderloin may be canned separately. Remove from carcass, wipe with damp cloth, and sear quickly in hot grease. Then season according to taste and roast until nicely browned. Cut in can lengths and pack into cans. Add hot gravy stock, prepared from pan grease with soup stock or hot water added, to within one-half inch of top of can. Seal at once, or, if packed cold, exhaust before sealing. Process:

No. 2 cans, 50 minutes at 250° F., or 15 pounds of steam pressure.

No. 3 cans, 65 minutes at 250° F., or 15 pounds of steam pressure.

The tenderloin may also be prepared as directed and packed in cans together with suitable vegetables (first boiled and seasoned), then sealed and processed as given above.

PORK CHOPS.

The chops are quickly seared in hot grease, salt and pepper (to taste) are added, and they are cooked until done and nicely browned. The bone may be removed and a short piece of boiled macaroni substituted. Then pack into cans about half full and fill in with boiled string beans, spinach, sauerkraut, or small, nicely browned potatoes. If desired, some gravy stock may be added. Exhaust 5 minutes, seal, and process.

No. 2 cans, 60 minutes at 250° F., or 15 pounds of steam pressure.

No. 3 cans, 75 minutes at 250° F., or 15 pounds of steam pressure.

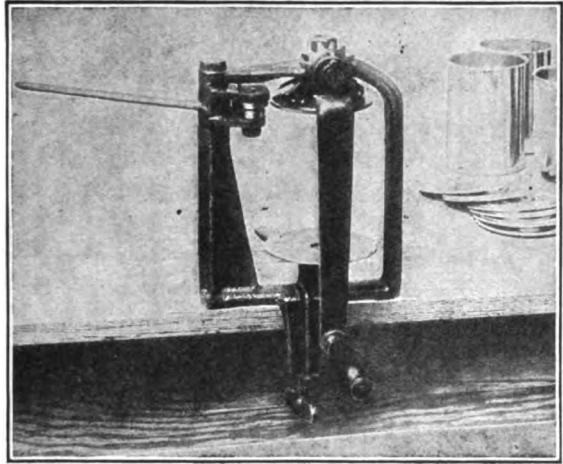


FIG. 22.—Small hand sealer for No. 2 cans.

In case it is preferred to leave the pork rib on the chop, when packed in the cans, add 15 minutes to the processing period given above.

TONGUE.

Tongues may be cleaned, salted, and lightly smoked, then boiled, skins removed, and packed in cans with a little soup stock or meat jelly added. They may also be cleaned thoroughly, rubbed heavily with salt, and left standing with salt sprinkled over them for 8 to 10 hours. Then boil until done, remove the skin, and pack in cans with a little of the liquid in which they were boiled (thinned with some boiling water in order not to be too salty). In either case cap, tip, and process:

No. 1 cans, 40 minutes at 250° F., or 15 pounds of steam pressure.

No. 2 cans, 50 minutes at 250° F., or 15 pounds of steam pressure.

BRAINS.

The brains should be soaked in several changes of cold water to draw out the blood, and the membranes removed. The brains may then be fried in hot grease, sprinkled with salt and pepper, packed in No. 1 flat cans, and the grease in which the brains were fried, thinned with a little hot water, added. Cap, tip, and process:

No. 1 cans, 45 minutes at 250° F., or 15 pounds of steam pressure.

HEADCHEESE.

Cut a hog's head into four pieces. Remove the brains, ears, skin, snout, and eyes. Cut off the fattest parts for lard. Put the lean and bony parts to soak overnight in cold water in order to extract the blood and dirt. When the head is cleaned put it over the fire to boil, using water enough to cover it. Boil until the meat separates readily from the bones. Then remove from the fire and pick out all the bones. Drain off the liquor, saving a part of it for future use. Chop the meat fine with a chopping knife. Return it to the kettle and pour on enough of the liquid to cover the meat. Let it boil slowly for 15 to 30 minutes. Season to taste with salt and pepper just before removing it from the fire. Bay leaves, a little ground cloves, and allspice may be added and boiled for awhile in the soup. It not condensed enough to form jelly, a little gelatin may be dissolved in cold water and mixed well with the cheese just before filling into the cans. Pack while hot in cans to within one-half inch of top. Cap, tip, and process:

No. 2 cans, 50 minutes at 250° F., or 15 pounds' pressure.

When ready to serve, thoroughly chill the can before opening. Serve cold.

KIDNEYS.

The kidneys after being split open and the little sack inside removed should be soaked in several changes of lightly salted water. They should be cut into slices about one-fourth to one-half inch thick, lightly seared in hot grease, sprinkled with salt and pepper, and fried to a brown color. Then pack in cans with onions that have been peeled, sliced, and nicely browned in hot grease. Then pour in hot gravy made from adding water to the pan grease until the can is filled to within one-half inch of top. Cap, tip, and process.

No. 2 cans, 45 minutes at 250° F., or 15 pounds of steam pressure.

No. 3 cans, 55 minutes at 250° F., or 15 pounds of steam pressure.

Kidneys may also be prepared as a stew or ragout and filled hot into cans. Cap, tip, and process for same length of time as for fried kidneys.

BOLOGNA-STYLE SAUSAGE.

To each 10 pounds of lean beef use 1 pound of fat pork, or bacon, if preferred. Chop fine and season with 1 ounce of salt to each 4 pounds of meat, 1 ounce of the best black pepper (ground, pure) to each 6 pounds of meat, and a little ground coriander. Stuff into casings called beef "middles" or beef "rounds," and smoke for 10 to 12 hours. Cook in boiling water until the sausages float. Take up the

sausage, cut in can lengths, pack into cans and add hot liquid, in which the sausages were cooked, to within one-half inch of top. Cap, tip, and process:

No. 2 cans, 45 minutes at 250° F., or 15 pounds of steam pressure.

PURE PORK SAUSAGE.

An excellent pork sausage may be made by using three parts of fresh lean pork to one part of fat pork. Cut into small pieces and pass through meat grinder, using a rather coarse plate. Weigh the meat, and for 25 pounds add one-half pound salt, one-half ounce fine sage, one-fourth ounce ground nutmeg, and from one-half to 1 ounce of black pepper. Mix thoroughly and pass again through meat grinder, using a small plate. Form into little round or flattened cakes and fry in deep fat until nicely browned. When several panfuls have been cooked, pour off the grease and add water to the brown parts in bottom of pan to make gravy stock. Add this while hot to the packed cans. Return the grease to pan and cook another panful of sausage cakes. When packed hot, seal cans (partly seal glass jars), and process:

No. 2 cans, 45 minutes at 250° F., or 15 pounds of steam pressure.

No. 3 cans, 55 minutes at 250° F., or 15 pounds of steam pressure.

Sausage cakes may also be canned without any liquid gravy stock added. Pack cans to within one-half inch of top of can. Exhaust from 3 to 5 minutes, seal, and process:

No. 2 cans, 75 minutes at 250° F., or 15 pounds of steam pressure.

No. 3 cans, 90 minutes at 250° F., or 15 pounds of steam pressure.

PORK CAKES.

Use the following ingredients:

4 pounds lean pork.
2 pounds fat pork.
2 or 3 tablespoons salt (or salt to taste).
1 teaspoon black pepper.
1 teaspoon red pepper.
1 teaspoon Chile pepper (to taste).
½ teaspoon allspice.
2 or 3 teaspoons sage (or poultry seasoning).
½ to 1 teaspoon thyme.

2 large onions, minced.
1 clove garlic, minced (may be omitted).
2 bay leaves, powdered or broken into small pieces.
1 teaspoon celery seed, crushed (may be omitted).
6 to 12 tablespoons dry, finely chopped bread or cracker crumbs.
2 eggs beaten together.
½ cup to 1 cup of sweet milk.

Knead well, form in cakes, fry in deep fat until nicely browned, pour off excess of grease, add water, and make gravy. Two or three cookings may be made in one lot of grease. Pack in cans, fill in with hot gravy to within one-half inch of top of can. Cap, exhaust 5

minutes (exhausting is not necessary if packed hot in cans and sealed at once). Tip, and process:

No. 2 cans, 45 minutes at 250° F., or 15 pounds of steam pressure.

No. 3 cans, 55 minutes at 250° F., or 15 pounds of steam pressure.

LIVER SAUSAGE.

Remove the membrane and cut away the large blood vessels. Soak in water 1 to 2 hours to draw out blood. Boil until done. When cooled put through a food chopper or grate fine. Take half as much boiled fat pork as liver. Divide this fat into two portions; chop one portion into $\frac{1}{4}$ -inch cubes; pass the other portion through the food chopper; mix all together thoroughly; add salt, ground cloves, pepper, and a little grated onion to taste. A little thyme and marjoram may be added to suit taste. (For a liver weighing 3 pounds add $1\frac{1}{2}$ pounds fat pork, from 6 to 8 teaspoons salt, 1 teaspoon cloves, 1 teaspoon pepper, 2 small onions, $\frac{1}{2}$ teaspoon thyme, and pinch of marjoram.) This mixture is stuffed into large casings (if no casings are available, make casings of clean white muslin). Cover with boiling water, bring to a boil, and boil for 10 minutes. Pack in cans and fill in with the water in which the sausages were boiled. Cap, exhaust 5 minutes if cooled (if packed hot, exhausting is not necessary), tip, and process:

No. 2 cans, 50 minutes at 250° F., or 15 pounds of steam pressure.

No. 3 cans, 65 minutes at 250° F., or 15 pounds of steam pressure.

This liver sausage may also be made from the raw liver and raw pork. In that case proceed in same manner as just described, but process the cans 10 minutes longer at temperature given. It may be served hot or cold.

HOG-LIVER PASTE.

1 medium-sized liver (about 3 pounds).	1 teaspoon ground cloves.
$1\frac{1}{2}$ pounds fresh fat pork.	1 small onion, grated.
$\frac{1}{2}$ pound butter.	3 eggs.
$\frac{1}{2}$ pound flour.	Milk (as needed).
1 teaspoon pepper.	Salt to taste.

The fat is chopped very fine. The butter and flour are rubbed together in a kettle placed over the fire, then thinned with milk to a very soft gruel. Into this put the chopped fat. Cook over a very slow fire, in order not to scorch, until fat is pretty well cooked out.

In the meantime get the liver ready. Wash well, remove the skin, and cut away all veins and membranes. Scrape or pass through a meat grinder, then place this mass on a fine sieve or strainer. Into it pour the warm thickening little by little and together with the liver rub through. Into this liver mass as passed through the sieve stir 3 yolks of eggs, 1 teaspoon pepper, 1 teaspoon ground cloves, plenty

of salt (about 2 tablespoons or more, according to taste), 1 small grated onion, and the beaten whites of the 3 eggs. Put into cans that must not be entirely full. Cap, exhaust from 5 to 8 minutes, tip, and process:

4-ounce glass jars, 40 minutes at 250° F., or 15 pounds of steam pressure.

No. 1 flat tin cans, 45 minutes at 250° F., or 15 pounds of steam pressure.

A very good liver paste can be made by taking liver and fat pork, as in recipe above, pass through meat grinder twice, stir well with 2 tablespoons salt, 1 teaspoon pepper, 1 teaspoon ground cloves, 1 finely chopped medium-sized onion, 6 tablespoons cracker or dried-bread crumbs, 3 eggs beaten together, and one-half cup of sweet milk. Fill into cans; cap, exhaust, tip, and process as stated.

GOULASH.

2 pounds cleaned pork heart.	6 whole peppercorns.
2 ounces butter or any good fat.	1 blade mace.
2 onions (medium size) chopped fine.	1 pinch thyme.
1 carrot (medium size) finely sliced.	1 tablespoon parsley (finely chopped).
1 stalk celery cut in small pieces.	Salt and pepper to taste.
1 pint tomatoes (canned or fresh).	Paprika to taste.
1 bay leaf, broken in pieces.	A little flour.
6 whole cloves.	

Cut the hearts into 1-inch cubes and sprinkle with flour mixed with salt and pepper. Melt butter or fat in a frying pan. When hot add the chopped onions, carrot, and celery, and brown lightly. Add the meat, prepared as stated, and brown while stirring frequently with a spoon to prevent scorching. When nicely browned empty into a stewpan, add bay leaves, cloves, peppercorns, mace, and thyme tied up in a little bag of cheesecloth, also tomatoes or tomato purée. Cover with soup stock or water and simmer for 45 minutes (for 2 hours if to be served at once and not canned). Remove the bag of spices and season by adding salt, pepper, and paprika to taste. Soy or Worcestershire sauce may be added in small quantities if desired. Add the parsley. Fill hot into cans, seal at once, and process:

No. 2 cans, 50 minutes at 250° F., or 15 pounds of steam pressure.

No. 3 cans, 60 minutes at 250° F., or 15 pounds of steam pressure.

If the different ingredients in this recipe are not at hand, a good goulash may be made by using meat, fat, onions, tomatoes, flour, salt, and pepper, leaving out the other ingredients.

SCRAPPLE.

The cleaned head, feet, all bones cut out of fresh or cooked meat with what meat clings to them, the liver, heart, and all meat scraps not otherwise used may be utilized for making scrapple. Put over

the fire in cold water enough to cover, bring to a boil, and cook until meat falls from the bones. The cleaned skin cut off when preparing the fat for rendering lard can also be used. Put it into the steam-pressure cooker on top of rack and add cold water to cover the skin. Cook at 10 to 15 pounds' steam pressure for one hour. The bones, head, feet, liver, etc., also may be cooked under steam pressure, whereby considerable time is saved, but should not be cooked together with the skin, as it will be more difficult to separate the small pieces of bones when mixed with the cooked skin. Strain the resulting liquid or soup from the bones and from the skin. If too greasy, part of the fat may be skimmed off. Carefully pick out all bones from the meat. Then chop the meat and boiled skin fine and return to the soup. Put over the fire again and bring to a boil. Season to taste with salt and pepper (generally $2\frac{3}{4}$ ounces of salt and one-half ounce of pepper for each gallon of liquid). To this boiling soup and meat add slowly under constant stirring, to prevent lumps, a mixture of corn meal, buckwheat flour, and wheat middlings until it is as thick as mush. (The mixture is in the proportion of 50 parts of fresh corn meal, 25 parts of buckwheat flour, and 25 parts of clean wheat middlings.) Stir vigorously while the scrapple is allowed to cook for from 10 to 15 minutes. Remove from fire and pour hot into cans to within one-half inch of top. Seal at once and process:

No. 2 cans, 50 minutes at 250° F., or 15 pounds of steam pressure.

No. 3 cans, 70 minutes at 250° F., or 15 pounds of steam pressure.

The scrapple should be removed from the can, sliced, and browned in a frying pan before serving.

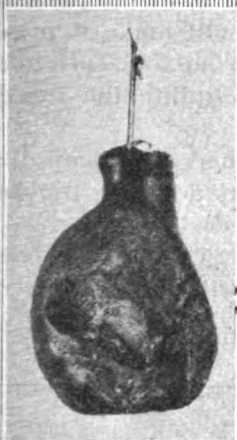
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No. 1186

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1186

PORK ON THE FARM

KILLING, CURING, AND CANNING



WARM, freshly slaughtered pork carcasses should be chilled to a temperature between 34° and 40° F. within 48 hours, preferably within 24 hours, after slaughtering. Bacteria which may cause spoilage if their growth is not promptly checked by chilling are often present in the tissues of the hog.

Meat as it cures will normally develop a more uniform, desirable flavor if it can be held at an even temperature of about 38° F. On the farm temperatures are not easily controlled, but every effort should be made to approximate those mentioned.

Proper slaughtering equipment will make it possible to clean carcasses thoroughly so that full use can be made of all the parts, including the head and feet.

Clean, well cut, smoothly trimmed meat can be cooked and used to better advantage than pieces that have been improperly prepared.

Farmers who plan to sell home-cured products will find that a uniform flavor and an attractive appearance will be real assets.

Washington, D. C.

Issued February, 1921
Revised February, 1932

PORK ON THE FARM

KILLING, CURING, AND CANNING¹

K. F. WARNER. *Animal Husbandman, Animal Husbandry Division, Bureau of Animal Industry*²

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IMPORTANCE OF PROPER METHODS

MEAT IS A valuable and perishable product. Unless it is handled properly, the waste from unused, spoiled, and unpalatable parts more than offsets the possible advantages of farm curing.

Success in preparing meat foods depends upon strict attention to the methods used. No details of these methods are difficult, but all are important. Great care is needed when a farmer markets part or all of his hogs as meat and sells the products in his own community. Most consumers desire a uniform trim and flavor. To satisfy and make permanent an exacting trade, the pork must be cut and handled with the greatest care.

There are many different ways in which to prepare pork products. The best one for each farmer is that which suits his family or community. However, certain general principles of cutting and curing should be observed by all.

¹ This bulletin supersedes Farmers' Bulletin 913, *Killing Hogs and Curing Pork*, and is a complete revision of Farmers' Bulletin 1186, *Pork on the Farm, Killing, Curing, and Canning*, by F. G. Ashbrook, junior animal husbandman, and G. A. Anthony, lay inspector, Bureau of Animal Industry, and Frants P. Lund, Office of Cooperative Extension Work.

² Information on canning pork was furnished by Florence B. King, specialist in foods, Bureau of Home Economics.

EQUIPMENT

Elaborate and expensive equipment is unnecessary, but certain tools are essential and others are very desirable. (Fig. 1.) Most useful of all is the curved 6-inch skinning knife. It may be used for sticking the hogs, raising the gambrel tendons, shaving and dressing the carcass, and cutting and trimming the meat. It is also the best knife for skinning cattle and lambs. Once the user becomes accustomed to its shape, the curved knife will be found to cut more easily and smoothly than the straight butcher knife. A narrow-bladed boning knife, the narrower the better, is needed in preparing boneless roasts and meat that is to be canned.

In sharpening a knife a grindstone commonly is used first. With it an even bevel, about one-fourth inch wide, is put on each side of the blade. An oilstone is used to give a smooth, keen edge. A smooth, high-quality, 9 to 14 inch steel is essential in keeping the knife sharp. The steel is not used to sharpen a knife but to keep a

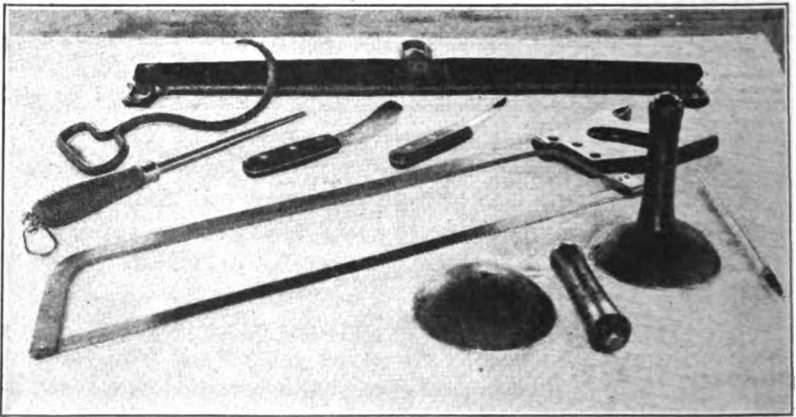


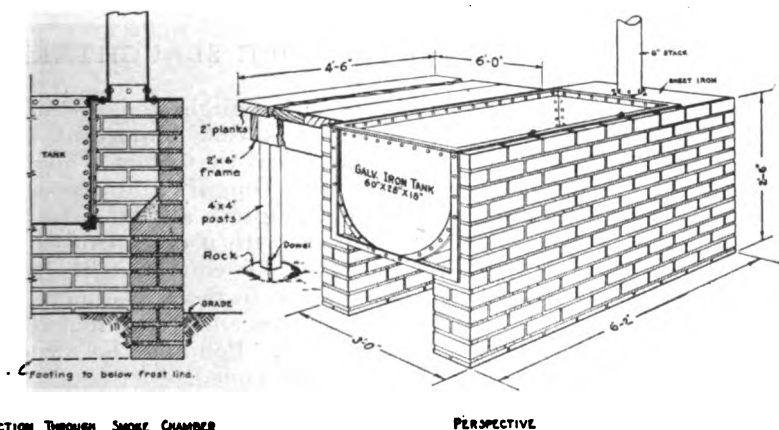
FIGURE 1.—Equipment for use in slaughtering and dressing hogs: Gambrel (single-free), hook, smooth steel, skinning knife, boning knife, saw, bell-shaped hog scrapers, and thermometer

sharp knife in good cutting condition. Use of the steel removes bits of fat and tissue from the edge of the knife and straightens or removes the "set" from the microscopic teeth that compose the edge. When they are purchased, most steels, even those of high quality, are too rough to be serviceable and should be rubbed down with an emery stone until the surface is smooth and glassy. A person not skilled in the cross-saber method of steeling used by experienced butchers may hold the knife in the left hand with the blade slanting downward and the point resting on the table and rub both sides of the edge lightly with the steel. One can form the habit of steeling the knife briefly but frequently while using it.

The meat saw should be 24 to 28 inches long. A saw of this length can be used instead of a cleaver for splitting either hog or cattle carcasses. The bell-shaped hog scrapers, an adaptation of the old-time candlestick holders, are the best hand instruments yet devised for removing the hair, scurf, and dirt. A fairly heavy steel scraper, with a bell that will take a rough edge on the outside when rubbed

with an emery stone or file, is the most efficient. A scraper 4 inches in diameter can be used more easily than larger sizes, whereas smaller scrapers are usually too light and do not hold their shape. A singletree with open hooks makes a more desirable gambrel for hanging the carcass than the customary notched stick as there is less danger of the carcass slipping off the singletree. When many hogs are to be killed, the use of commercial metal gambrels is suggested.

An ordinary 50-gallon hardwood barrel will serve to scald a hog weighing up to 250 pounds, without much difficulty. A metal trough or watering tank 5 to 6 feet long, 30 inches wide, and 15 to 24 inches deep may be converted into a combination water heater and scalding tank. It is set up on bricks or put over a trench. The sides are banked with earth and a fire built beneath. (Fig. 2.) This arrangement permits holding the temperature of the water at the proper point for scalding any number of hogs.



SECTION THROUGH SMOKE CHAMBER

PERSPECTIVE

FIGURE 2.—Combination water heater, scalding tank, and scraping table. The tank may also be set on the ground over a trench and banked with sheet metal or earth.

The most convenient scraping table is $4\frac{1}{2}$ feet wide, $2\frac{1}{2}$ feet high, and 4 to 8 feet long. (Fig. 2.) On a table of this width the hog can be laid crosswise so that one man may scrape the rear end while the other scrapes the head. A thermometer that will register up to 212° F. is desirable so that the temperature of the water can be correctly gaged.

A hog hook for use in scalding the animal; pans or tubs for holding edible and inedible offal; a block and tackle, ladder, rack, or other means for hanging and chilling all the carcasses that are to be dressed; and plenty of both hot and cold water should be provided before operations begin. A small blowtorch and wire brush will help materially in singeing and scrubbing the head and feet.

A salimeter (known also as a salometer and salinometer) operating on the same principle as the wet-battery hydrometer, may be used in measuring the saltiness of the curing brine. It is inexpensive, may be obtained at any butcher's supply house, and makes it possible to gage accurately the strength of the pickle needed to produce fully cured hams or mild bacon.

MEDIUM-WEIGHT HOGS MOST DESIRABLE FOR SLAUGHTER

A hog weighing from 180 to 225 pounds alive will produce moderate-sized cuts and usually a very desirable proportion of fat and lean. Heavier hogs will produce more lard.

When hams and shoulders are cut according to the methods later described, each will weigh about 7 per cent of the live weight of the hog. Each bacon strip and loin will weigh about 5 per cent and the head 7 per cent. The weight of lard rendered from a 200-pound live hog will range between 9 and 13 per cent of the live weight of the hog; and that from a 250 to 300 pound hog, between 14 and 18 per cent.

A smooth, thrifty, moderately well-finished hog will usually produce a desirable quality of meat. Of course the animal should be healthy.

CARE OF THE HOG JUST BEFORE SLAUGHTERING

The care of an animal just before it is slaughtered has much to do with getting a good "stick," which is very important because meat from a well-bled hog keeps better than that from a hog which has not bled well. A hog bleeds more thoroughly and dresses more easily after a 24-hour fast but it should be given all the water it will drink. Running the animal or wrestling with it often causes a temporary fever. If the animal is killed in this condition, the meat is likely to be bloody and slimy, sometimes referred to as fiery. Such meat looks bad and spoils easily. Bruises and whip marks cause bloody spots which must be trimmed out. Penning the animal by itself the day before butchering is recommended.

STICKING

The blood will drain out more completely if the hog is stuck without being shot or stunned with an ax. Furthermore, sticking without stunning, which is the common commercial practice, is not considered to be more cruel than the other methods. To get the hog in a proper position for sticking, reach under the animal and grasp its opposite front leg; then roll it upon its back and hold it as shown in Figure 3. The following sticking method is recommended for the beginner.

The man doing the sticking takes a position squarely in front of the hog, holds down the snout, and opens the skin for a distance of about 3 inches in front of the breastbone. He then inserts the knife, edge downward, straight in toward the breastbone, not downward, as is often done. When the breastbone is reached, he follows downward with the point of the knife until the knife slips under the breastbone and between the ribs. He then pushes the knife in about 1 inch and directs the cut first downward toward the backbone, then forward toward the head. Care should be taken to hold the animal squarely on its back and to keep the knife in the center so as not to stick a shoulder. It is both difficult and unwise to stick the heart. Let it pump out the blood as long as possible.

SCALDING

Slow scalding is usually best. At slaughterhouses where steam is available to maintain the scalding water at a steady temperature, the water is usually held at 140° to 144° F. With these temperatures it will take from 3 to 6 minutes to loosen the hair and scurf, but there is little or no danger of setting the hair or cooking the outside of the skin. In the fall of the year when the winter hair is beginning to grow and most pigs are difficult to scald, temperatures as high as 146° to 150° are sometimes used.

On the farm, where it is impossible to reheat the water promptly, temperatures of 155° to 165° often must be used at the beginning so that the water will not become cold before the hog is completely cleaned. In using water as hot as this, care must be taken to keep the



FIGURE 3.—Sticking the hog. Note that the feet of the man holding the hog are pressed against the shoulders of the animal to prevent its rolling

hog in motion (fig. 4) while in the water and to pull it from the barrel and give it frequent chances to cool and air. This lessens the danger of setting the hair. If at all possible, it is advisable to have plenty of boiling water available so that lower temperatures can be used at the beginning and more hot water added if necessary. The combination heater and scalding tank shown in Figure 2 is the most convenient means for obtaining the proper temperature.

Lime, rosin, or other substance that will make the hair cling to the scraper and pull out more easily is often put into the water. Many persons use some form of soap or alkali. This makes the hair a bit slippery but helps to loosen the dirt on the skin. The proper temperature of the water, however, is more important than any substance that can be put into it.

Twenty-five to thirty gallons of water is ordinarily enough to scald a hog in a 50-gallon barrel. Light or medium-weight hogs can be

practically immersed in the barrel. The animal is held with a hook in the lower jaw. In scalding large hogs the ham end of the animal is immersed first and then the head end. When the latter end is immersed, one leg of the hog is held with the hook caught in the gambrel tendon. At this time, a third man, if available, can remove most of the hair from the hot legs and flanks even though the animal is kept in motion.



FIGURE 4.—Scalding the hog. Keeping it in motion lessens the danger of setting the hair and works the water into the wrinkles of the skin

SCRAPING

When the hog is completely scalded turn it crosswise on the table. One man should grip the hind legs with both hands and twist off the hair, then pull off the dewclaws and toes, while hot, with a hook, and scrape the hog from fore flank to tail. (Fig. 5.) Another should scrape the hair from the wrinkles and rough parts of the head and forelegs. After some experience, one will learn to stretch the skin by moving the leg or head so as to smooth the wrinkles

and make scraping easier. If patches of hair have not been thoroughly scalded, it is often possible to loosen them by covering them with sacks or hog hair and pouring hot water on them.

After the hair and scurf have been scraped off, much of the dirt can be removed by rinsing the carcass with warm water and pressing the bell scraper flat against the carcass, instead of tipping it on its edge as before. (Fig. 6.) A blowtorch and wire brush will now be very useful in singeing and scrubbing the head and feet. (Fig. 7.)

The scraped, singed carcass is ready to be rinsed with cold water and shaved. (Fig. 8.) Wash and shave the entire carcass. It is now ready to be hung up. To insert the gambrel, open the skin at center of hind leg just above the foot and directly over the tendons. Push the skin aside with the knife and cut down to the bone at the side of the tendons, as shown in Figure 9. Make a similar cut on the other side of the tendons. Put the knife aside and raise tendons with the fingers to receive the gambrel. Be sure the gambrel stick or hook engages both

tendons. After the gambrel is raised and the carcass is suspended, wash the carcass again with cold water and shave it again.



FIGURE 5.—In scraping the carcass tilt the scraper on its far edge and pull forward. Use both hands and plenty of pressure

OPENING AND DRESSING THE CARCASS

Opening a hog carcass and dressing it are really very simple operations, particularly if the hog has been kept off feed for 24 hours before slaughter. There are many different methods, but the following should be easily understood by the beginner.

Insert the skinning knife, edge up, into the sticking place and cut up through the full length of the breastbone. (Fig. 10.) If the breastbone is very hard to cut, as it may be in older hogs, the cut may be made about one-fourth inch to one side of the middle where there is softer bone or cartilage. It is sometimes necessary to use the saw.

Now begin at the other end of the hog and cut down between the hams, taking care to keep the knife in the center. As the hams



FIGURE 6.—To remove the dirt, press the scraper flat against the wet skin and move it rapidly back and forth. This creates a suction that will remove much dirt and stain

open, the white membrane which marks the exact middle can be seen. Follow this, if possible, to the bone. If one misses the middle "seam," correction may be made by a small bony projection that can be felt with the finger just underneath the front (forward side) of the pelvis. If the knife is directly above this projection, there is usually little difficulty in cutting the hams apart. Use the saw if necessary. In dressing a barrow, loosen the penis and let it hang, to be removed later with

the "bung." Insert the handle of the knife in the opening made in splitting the hams, with the point of the knife pointing outward.

Guard the heel of the blade with the forefinger and thumb of the right hand and cut down the middle line of the belly until this cut joins the split breastbone. (Fig. 11.)

Allow the intestines to roll out and hang. Raise the bung by slipping the knife into the pelvic cavity and loosening the bung on both sides and at the back. Pull it down toward and past the kidneys. Be careful to cut it free from the kidney fat. (Fig. 12.)

It is at this point that many inexperienced farm butchers expect to encounter trouble. The operation, however, is almost complete



FIGURE 7.—Cleaning the head. The head is scalded and singed, then scrubbed with the wire brush.

and no difficulty need be anticipated. With the left hand grasp the intestines firmly just below the kidneys at the point where they appear to be attached to the backbone. Push down slowly but firmly until they loosen from the back. Free the liver by running the fingers of the right hand behind it and pulling it away from the back. Still holding the intestines in the left hand, cut through the diaphragm to the backbone. (Fig. 13.) Extend the cut around the white fibrous diaphragm, which is parallel to the ribs, to the breastbone and down the breastbone to the throat. This last cut loosens the heart and lungs in the chest cavity.- Still holding the intestines with the left hand, repeat the cut on the left side of the carcass, crossing the right hand over the left. It may sometimes be necessary to cut the back artery from the backbone, thus permitting the left hand to pull the entire offal out of the carcass. The gullet is still attached to the throat but one cut of the knife will free it.

If the carcass is fouled in dressing, thoroughly wash it in cold water; then split it. Splitting with a saw down the center of the

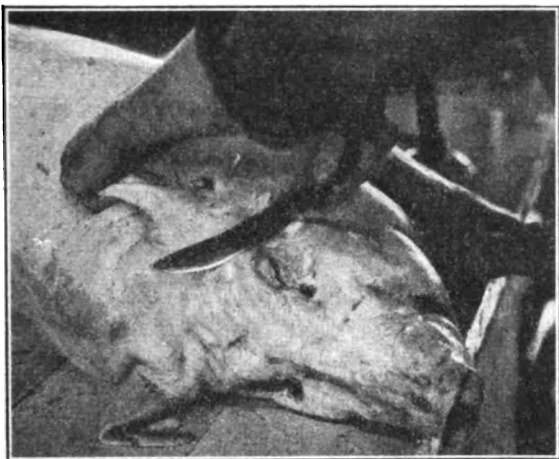


FIGURE 8.—In shaving the animal, stretching the ears, jowls, legs, and other parts will smooth out the wrinkles and make shaving easier

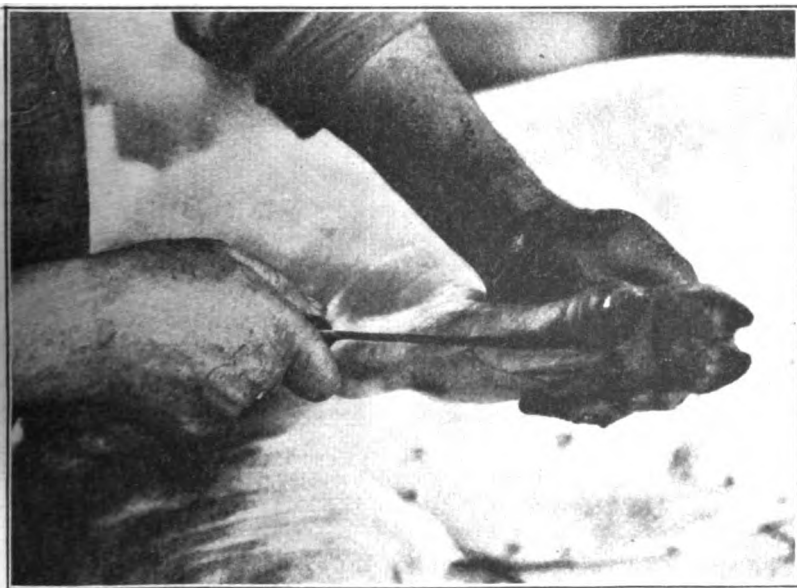


FIGURE 9.—Raising the gambrel tendon

backbone is recommended. This eliminates the savory country-style backbone piece or chine but gives a larger quantity of meat suitable for curing and canning.



FIGURE 10.—In splitting the breastbone, if the handle of the knife is slanting up with the point down there is little danger of cutting up too far and opening the paunch.



FIGURE 11.—Under this method of opening the carcass there is no danger of cutting the intestines.

The split carcass will chill more rapidly if the leaf fat is pulled out by loosening it where it is attached to the diaphragm at the last

rib and stripping or fisting it up and out. (Fig. 14.) It is also much easier to remove the leaf fat when the carcass is hot than after it has been chilled.



FIGURE 12.—The offal will not fall unless the pig has been fed shortly before slaughter



FIGURE 13.—In removing the intestines, grasp the offal carefully and firmly so that it will not fall and tear

In commercial practice, where carcasses are inspected, the head of the hog is unjointed before the carcass is opened. This operation requires a little skill but is readily learned. A cut is made about one-half inch above the ear, at right angles to the backbone, and clear

through the left jowl and top of the neck and throat. The left ear is held with the left hand, and the cut is made in to the backbone. This leaves the head hanging by the bone and right jowl. The cut should meet the neck joint where the first neck bone joins the head. The dished "button" end of the backbone fits over the head end of



FIGURE 14.—The warm leaf fat is pulled out by loosening it at the rib end and fistng it up and out

the joint in the same manner that the fingers and palm of one hand can be made to inclose the clenched fist of the other. The knife loosens the membranes at the lower or head end of the joint, the end of the "fingers" of the upper or inclosing "hand." As the joint opens, the knife moves upward along the "knuckles" of the clenched "fist," across its top, and down the far side. The whole joint is about $1\frac{1}{2}$ inches wide. Packers often unjoint the head by cutting across above the ears, peeling off the jowls, and allowing them to remain upon the carcass.

CHILLING THE CARCASS

The tissues of many freshly slaughtered hog carcasses contain bacteria that are capable of spoiling the meat unless their growth is promptly checked. Packers have practically solved the problem of sour meat by chilling the fresh, warm carcass to a temperature of 34° to 36° F. within 24 hours after slaughter and by holding the meat at 36° to 40° while it is curing.

Many communities in the South have access to local cold-storage plants with facilities both to chill the carcass and to store the curing meat. The warm sides are brought in immediately after slaughter, and the owner returns one or two days later to cut the pork and put the meat in cure in the drawer, box, or bin assigned to him. The fresh cuts, lard, etc., are taken home. When nights are fairly cool the hogs are often dressed in the afternoon and allowed to hang overnight. The meat is cut and trimmed the next morning and the curing pieces taken to cold storage. Where a community cooperates with a cold-storage plant nominal charges to the farmers can often be obtained.

If the weather becomes warm and no cold storage is available, the warm sides may be cut up and the individual pieces hung up to air and cool, or immersed in a weak, ice-chilled salt brine containing about 8 pounds of salt to each 7 gallons of water. Sometimes insufficiently cooled pieces are salted with a dry-cure mixture and spread on a rack where they will have as much ventilation as possible. None of these methods is as safe or as satisfactory as storing the meat at the proper temperature, either natural or artificial.

CARE OF THE OFFAL

The principal edible parts of the offal are the liver, heart, tongue, and fat. The liver should be separated from the remainder of the offal and the gall bladder removed. The small, upper end of the gall bladder can be lifted with the thumb and finger and the bladder peeled out. The heart is cut off through the auricles or "ears." The tongue is removed at its base. All three parts should be washed promptly. They may be chilled in cold water and hung up for further chilling and drying. The caul fat can be separated from the stomach with the hands. The small intestines are removed or "run" from the ruffle fat by pulling the fat in one direction with the right hand and the intestines in the opposite direction with the left. The ruffle fat is then peeled off. This fat, if not fouled in dressing, should be saved for lard. It should be thoroughly washed and promptly chilled in cold water. After chilling it is hung up to drain and dry before being rendered.

CUTTING THE CARCASS

There is no one best method for cutting a pork carcass. The choice depends on how the pork is to be used. If it is to be sold the cuts should conform to local preferences. When the carcass is to be shipped it is customary to leave the head on, for convenience in handling and economy of shipment. If the meat is to be preserved by freezing, as is done in northern localities, each piece should be of a size and character suitable for a single meal. The purpose of the method described here is to produce the maximum quantity of meat that can be cured and stored for summer use and the minimum number of parts that must be used fresh. (Fig. 15.) This cutting method separates the thick, lean ham, loin, and shoulder from the thinner bacon strip, fat, and head.

If the head was not removed in dressing, lay the carcass on its side and cut off the head about one-half inch behind the ears. Cut to

the bone and entirely around it. The head may then be twisted off at the neck joint.



FIGURE 15.—Cuts of pork: *a*, Ham; *b*, loin; *c*, bacon strip; *d*, shoulder; *e*, head; *f*, feet

curve in the backbone at the shoulder end and at the edge of the tenderloin muscle at the ham end. Lay the middle skin side down,

If the carcass was not split when warm, now is the easiest time to split it. Place the cold carcass, with the head removed, upon its back with the hams extending beyond the table. Stand between the hams, and start the saw through the forward or shoulder end of the backbone. Saw from the inside toward the skin. As the shoulders are split, the two sides will spread apart, permitting more freedom in sawing the loin and last the hams.

A 3-rib shoulder is removed by sawing between the third and fourth ribs parallel to the head cut. (Figs. 15, *d*, and 16.) A long ham is cut off just behind the rise in the pelvic arch and at right angles to the direction of the hind leg. The more popular short ham is cut through the second vertebra behind the rise. To make the desirable square-top ham, the saw should be at exact right angles to the shank. (Figs. 15, *a*, and 17.)

Cut the thick loin (Fig. 15, *b*) from the thin bacon strip (*c*) just below the

and saw across the ribs, as shown in Figure 18. Remove the back fat from the loin by cutting down both sides of the loin, as shown in Figure 19, then raise the fat, and loosen it down the center. If the carcass has been split down the center the whole muscle of the

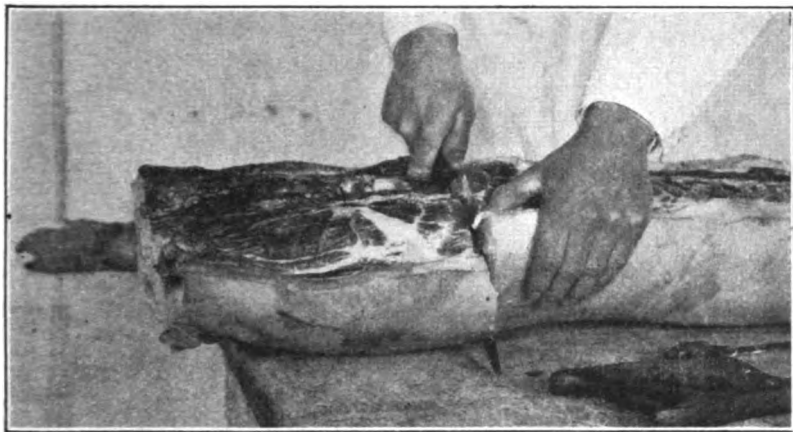


FIGURE 16.—Removing the 3-rib shoulder

loin can be easily boned out for sausage or for canning. Unboned, it is suitable for chops and roasts. It may also be given a mild cure.

If the leaf fat is still on the bacon strip, cut it free along the rib end, loosen it by bending the bacon over the edge of the table, and

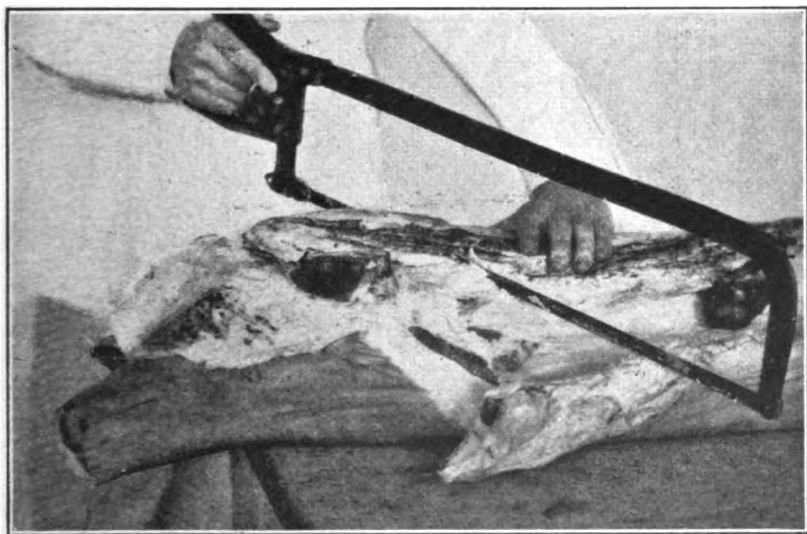


FIGURE 17.—In cutting off the square-top ham, saw at right angles to shank

then pull it out. (Fig. 20.) In removing the spareribs the edge of the knife is kept against the ribs. This will leave most of the meat on the bacon. (Fig. 21.)

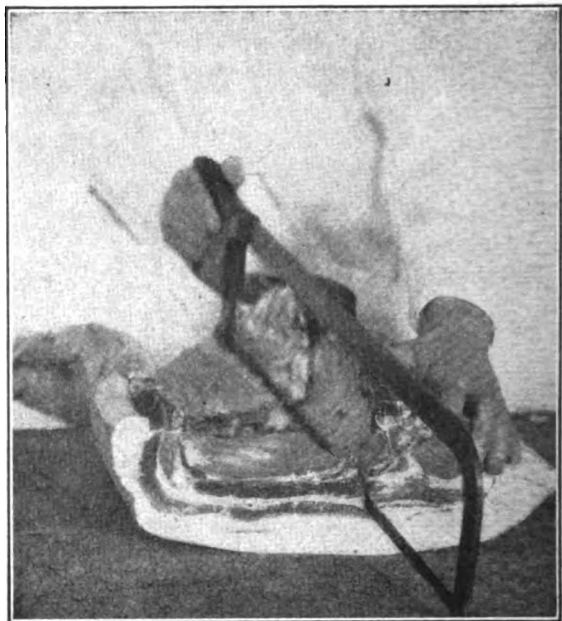


FIGURE 18.—In sawing the loin from the bacon strip, cut and saw through the leaf lard if it was not pulled off when warm



FIGURE 19.—Removing the back fat from the loin. One-fourth to one-half inch of back fat is usually left on the loin



FIGURE 20.—Bending the untrimmed bacon strip over the table edge to loosen the cold leaf fat

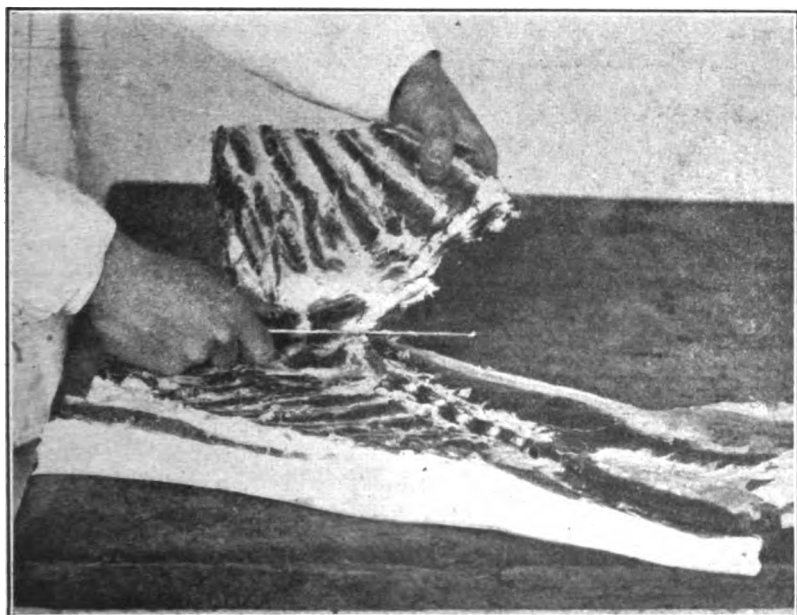


FIGURE 21.—The soft white ends of the spareribs are left in the bacon to give it a smoother, more attractive appearance

The jowls may be cut from the head, trimmed, and cured. After the eyes, nasal passages, teeth, and incompletely cleaned parts of the ears and snout have been removed, the rest may be used with the liver, heart, and tongue for cooked products.

The lean in all trimmings should be saved for sausage. A proportion of two-thirds lean and one-third fat is the popular combination. Many persons prefer to remove the skin from the fat (Fig. 22) before cooking the lard as the fat alone renders more satisfactory. If the skin is clean, however, it need not be removed.



FIGURE 22.—In skinning the fat trimmings, keep the knife parallel with the table and the edge turned slightly downward toward the skin

PICNICS AND SHOULDER BUTTS

The trimmed 3-rib shoulder may be divided into a shoulder butt, a picnic shoulder, and plate, if desired. (Fig. 23.) The top third of the shoulder is cut off as the butt, the extra fat or plate being re-

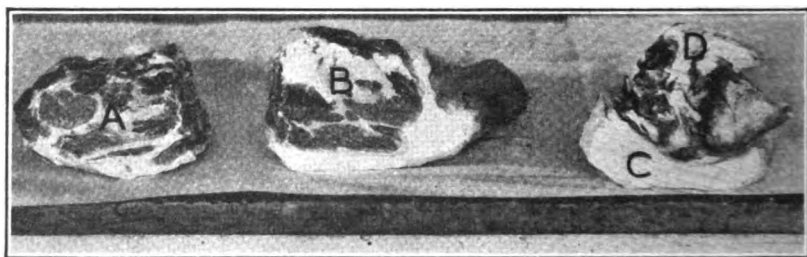


FIGURE 23.—A, Shoulder butt; B, picnic shoulder; C, plate; D, trimmings

moved from the lean butt. This 2 to 4 pound butt makes a very acceptable fresh roast. If the butt is to be cured, the end of the shoulder blade is ordinarily removed and the boneless piece cured with the bacon. The plate may be cut up for lard or cured as salt pork with the fat back. The picnic shoulder, or remaining shank end, is trimmed or rounded evenly and cured with the hams and shoulders.

TRIMMING CUTS FOR CURING

All meat to be cured should be trimmed smoothly and evenly. Care should be taken to remove all blood spots, to be looked for es-

pecially in the shoulder. The brisket and ragged neck pieces should be cut from the shoulder, the tail and flank from the ham, and the uneven edges from the belly. Leave some fat as protection on the face or inside of the ham. Excess fat on hams and shoulders may be removed, though the pieces will store more satisfactorily in summer if not skinned. The bacon should be flattened out with the hands or with the side of a cleaver, and squared on all four sides. The jowls and fatbacks, if these cuts are to be cured, should be treated in the same way. Spareribs and loins may be given a light cure without further trimming. Figure 24 and the cover page show the difference between poorly trimmed and properly trimmed hams, bacon, and shoulders.

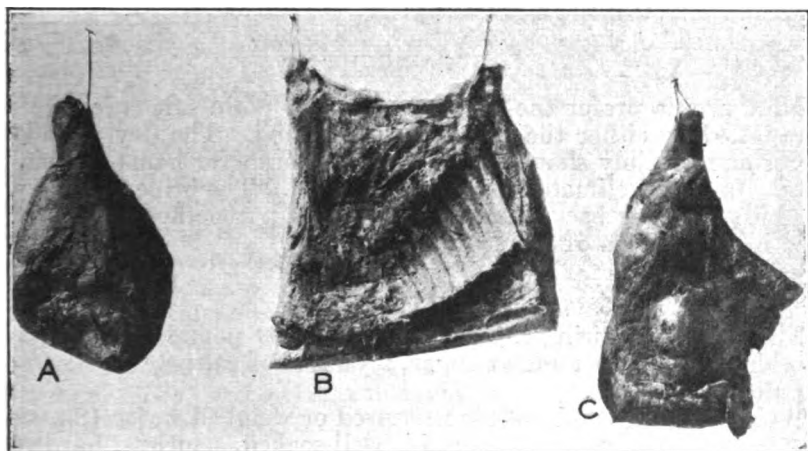


FIGURE 24.—Poorly trimmed ham (A), bacon (B), and shoulder (C)

CURING PORK

In commercial packing houses, well-chilled pork cuts are cured at a temperature of about 38° F. This temperature can not be maintained on the farm, but the curing meat should be put in a cool place where the temperature will remain as nearly uniform as possible. If the meat has been frozen it should be defrosted to a temperature of 34° to 40° before it is put in cure.

STANDARD PRESERVATIVES

SALT

Salt preserves and dries meat, but in excessive quantities will impair the flavor and make the lean muscles undesirably hard. Insufficient quantities will fail to check the development of putrefactive bacteria. A good grade of dairy or table salt is desirable.

SUGAR

Sugar is used mainly to lessen the harshness of the straight salt cure and to improve the flavor and texture of the meat. Brown or cane sugar or molasses may be used. Each gives its own characteristic flavor to the meat. Select the one that gives the desired flavor.

SALTPETER

Saltpeter (nitrate of potash) preserves and dries the meat but is used almost entirely because it effectively fixes the bright-red color of cured meat. Nitrate of soda may replace saltpeter. It is a little stronger, however, and 1.7 ounces of nitrate of soda will replace 2 ounces of saltpeter. The exact quantity of saltpeter or of nitrate of soda to be used should be weighed and mixed thoroughly in the curing mixture. It is undesirable and unnecessary to use more of either saltpeter or nitrate of soda than is recommended.

PEPPER

Pepper adds flavor and tends to repel insects, but, contrary to general belief, it is not a preservative.

SUGAR CURE

Most people prefer the sugar cure to the plain salt cure. It can be applied by either the dry or brine method. The dry method is faster and possibly should be used in the South for hams and shoulders. In colder climates either may be used. The brine method will produce a milder bacon than the ordinary dry method and may be used in all sections of the country.

BRINE METHOD

The standard curing mixture for each 100 pounds of meat is 8 pounds of salt, 2 pounds of sugar, 2 ounces of saltpeter, and $4\frac{1}{2}$ to 6 gallons of water.

Weigh the meat and put the measured or weighed water (8 pounds per gallon) into a crock or clean, well-soaked, odorless, hardwood barrel. Pour the curing ingredients into the water and stir until dissolved.

CURING HAMS, SHOULDERS, AND BACON

If a salimeter is available use a little less water to dissolve the salt than is suggested. Then test the strong pickle and dilute to proper strength. The standard curing mixture dissolved in $4\frac{1}{2}$ gallons of water will make a pickle that tests about 75° on the salimeter. This is excellent for curing hams and shoulders. When $5\frac{1}{2}$ gallons of water is used the weaker pickle, testing 65° , will produce a desirable mild bacon.

If the brine is sterilized by boiling, it should be thoroughly cooled before being used. Under ideal conditions both the brine and meat will be at a temperature of about 38° F. when the pack is put down.

The chilled hams and shoulders are packed away, skin side down, in the crock or barrel. Fit them closely together, but take care not to squeeze them out of shape. Pour in the cold, 75° pickle until the pack begins to shift or float a little. This movement permits the brine to come in contact with all parts of the meat. Then add a clean weight just heavy enough to keep the meat below the surface and cover the pack with pickle. Put on the weight first, or the pack will float out of shape.

On the fifth, fifteenth, and thirtieth days after being put down, the hams and shoulders should be overhauled; that is, they may be placed in another barrel and recovered with the same brine, or they and the brine may be removed and then replaced in the same barrel. This overhauling remixes the pickle and insures that the brine will come into contact with all parts of each cut.

The bacon strips are usually packed skin side down, each piece being crosswise of the one below it. Jowls or shoulder butts may be used to fill any unoccupied spaces. The milder, 65° pickle is used for bacon. Overhauling this meat on the third and tenth days is usually sufficient.

CURING TIME

Hams and shoulders are generally held in brine four days per pound; that is, a 15-pound ham will not be removed from cure until the sixtieth day. It is probably better to allow the small picnic shoulders 25 to 30 days in cure. Bacon can be cured in 1½ to 2 days per pound.

A thin scum of white mold normally forms on top of the brine. If, however, the mold becomes heavy and hard or if the pickle becomes ropy so that it drips from the fingers like sirup, the pickle should be changed. Remove the meat, scrub it thoroughly with a brush and warm water, and repack it in a cleaned and scalded barrel. The new brine, made after the original recipe, should be diluted to as nearly the saltiness of the old brine as possible. If the hams and shoulders have been in cure a week, use 70° brine instead of 75°; if more than two weeks, use 65° brine. Maintain the original curing schedule. This process may not save the meat but it is the only course available.

CURING LOINS, SPARERIBS, AND OTHER FRESH CUTS

Often the quantity of loin, spareribs, backbone, and other fresh cuts at butchering time is greater than the family can use promptly and economically. These cuts can be preserved by curing as well as by canning and, in the Northern States, by freezing.

A mild 55° to 65° brine, which contains about 6 gallons of water, is best for the ribs. They can stand a light smoke after a week in cure but are acceptable without smoking.

The loin may be given a light smoke after about three weeks in a 65° brine or may be used without smoking.

Owing to the quantity of lean meat exposed, these cuts are likely to become dry and harsh if given a long cure or smoke. It will be more satisfactory to use the pickle mainly as a means for storing them a short time. Keep the temperature of this meat as near 38° F. as possible while it is curing.

CURING MEAT IN SUMMER

Hogs may be slaughtered in the summer and the meat preserved by the brine-curing method. The pork should be promptly chilled in iced brine and kept as cold as possible throughout the period of curing. A 75° pickle, which contains 4½ gallons of water, is probably

the safest for use at this time of year. The meat should be used promptly. This is an excellent way to save the meat of shotes that have been injured.

DRY METHOD

For dry-curing hams and shoulders, there are many different recipes that call for varying quantities of salt. Five pounds is generally sufficient if one is sure that all the salt will be absorbed by the meat. However, since some salt ordinarily falls off or drains away, 6 to 8 pounds is a safer quantity. In the South, where temperatures are often high, the 8 pounds of salt is probably better. More than this quantity should not be used as it may injure the flavor and make the lean muscle too hard.

Meat is likely to spoil, regardless of the quantity of salt applied, if the freshly slaughtered carcass and the curing meat are held at too high temperatures.

The following curing mixture is recommended for 100 pounds of trimmed pork: Six to 8 pounds of salt, $1\frac{1}{2}$ to 2 pounds of sugar, and 2 ounces of saltpeter. This is the well known 8-2-2 recipe and is the same as that used in making the brine cure.

Mix the ingredients thoroughly in a pan and divide into two equal parts by weight. Use one part for the first rubbing; use one-half of the other for overhauling the meat on the third day, and the other half for overhauling on the tenth day. In giving the first rubbing, sprinkle a little of the mixture in the bottom of the barrel. Put each ham or shoulder into the pan of curing mixture and rub it thoroughly. Force some salt into the hock and along the cut face of the butt, taking care not to injure the hand on the butt bone. Cover the face of the cut with the mixture and lay the piece carefully in place. Repeat the same process in overhauling. The pieces at the top of the original pack should be at the bottom when the meat is resalted.

The same curing mixture, with salt reduced to 5 pounds, will dry-cure 100 pounds of bacon. Overhauling on the third day will be sufficient.

Two days per pound is the standard curing time for the dry method. However, it is usually safer to keep 8 to 10 pound hams in the curing mixture for from 25 to 30 days. Farmers who wish to store this meat for summer use often remove the cuts at full time, string them, and allow them to hang at air temperature for about two weeks before smoking.

Fat backs and shoulder plates may be cured by either the dry or brine method. They are usually left in cure until used.

PICKLING PIGS' FEET

Special care must be taken to clean the feet thoroughly. The toes and dewclaws should have been removed when the carcass was dressed. The glandular tissue between the toes should be trimmed out and all hair and dirt removed. Unless they are cared for properly, feet begin to spoil about as quickly as any part of the carcass; therefore, after thorough chilling they should be put in cure at once. The clean, chilled feet are usually put in the ham pickle for from 15 days to 3 weeks and then cooked or simmered slowly until

tender. Cook them slowly enough so that the skin will not part too badly and the feet pull out of shape. The cured, cooked feet are then thoroughly chilled and packed in cold, moderately strong (35 grain) vinegar to which spices such as bay leaves or allspice may be added. The feet may be used at once or kept in the vinegar for three weeks or even longer.

Souse is made by cooking cured or uncured feet in a little water until the meat slips from the bones. The meat and strained soup in which the feet were cooked are then seasoned with vinegar and spice, brought to a good boil, put in molds, and allowed to jell. Additional cooked pork trimmings may be added.

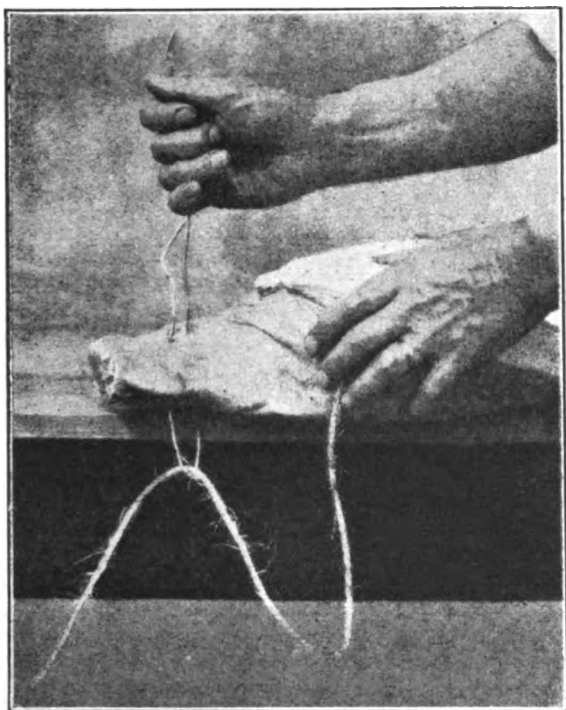


FIGURE 25.—Stringing a cured ham for smoking

SMOKING CURED MEAT

Smoked, cured meat will have a brighter color and a milder flavor if it is freshened in cold water before being smoked. Hams and shoulders are soaked about 2 hours and bacon about 30 minutes. Most farmers do not soak the hams and shoulders that are to be stored for summer use.

All pieces to be smoked should be strung and scrubbed with warm water to remove the excess salt and grease. Hams and shoulders should be strung through the shank. Unless a regular stringing needle is at hand make an opening through the shank with the narrow blade of the boning knife and pull a stout string through with a wire hook. (Fig. 25.) A wooden or wire skewer is usually run

through the flank end of the bacon strip and the string inserted just below it. (Cover page.) This keeps the piece square while it is hanging in smoke.

It is usually best to hang the cured, washed meat in the smokehouse overnight to drain and dry. Start the fire in the morning. If the meat is still dripping when smoking begins the lower pieces will be streaked. Hang the meat so that no two pieces touch.

Cured pork may be smoked at a temperature of 100° to 120° F. The ventilators should be left open, especially at first, to permit the moisture to escape. A heavy fog of smoke is unnecessary. Continue the smoking until the meat has the desired color. Two days should give it a rich mahogany brown.



FIGURE 26.—Temporary smokehouse. A covered trench, as shown, or a few lengths of stovepipe, connect the fire pit and the barrel

Meat that is to be aged or held for summer use is usually smoked more slowly. The temperature is held at 70° to 90° F. and the fires rebuilt intermittently over a period of from one to several weeks. This is as much a drying as a smoking process and is believed to assist in preserving the meat and in the normal development of the pungent flavor characteristic of smoked pork that has been aged several months.

Smokehouse construction may vary from the barrel type (fig. 26) to the elaborate 6 or 7 story buildings used by commercial plants, but the general design of all is the same. There is a damper at the bottom to regulate the draft on the fire, enough distance from fire to meat to protect the meat from scorching, and a damper in the roof to permit the escape of evaporated moisture and to control the passage of the smoke past the meat. A distance of 10 feet between meat and fire is safe. If the distance is only 5 or 6 feet, an inverted tub or metal shield should be placed above the fire to deflect the direct heat. A tight, preferably fireproof building, 6 feet wide, 6 feet long,

and 8 feet high, is a common type. Almost all cement or building-tile companies will supply plans for smokehouses, giving detailed directions for construction.

Green hickory wood and sawdust are the standard fuels for smoking meat, but almost any hardwood such as oak, apple, maple, or ash will be satisfactory. Where timber is scarce corncobs may be used. Any resinous wood will blacken the meat and give it an undesirable flavor. If paper or pine shavings are used to kindle the green hardwood, be sure that all have been completely burned or removed from the fire before the smokehouse door is closed.

A fire built after the Indian fashion, with the sticks radiating from the center like the spokes of a wheel, will become lower and cooler as it burns. Building such a fire is a good precaution, for inattention to a hot fire has ruined the meat in many a smokehouse. Green sawdust may be used to deaden the blaze.

Under the provisions of the Federal meat inspection act the use of liquid smoke, smoked salt, and like preparations intended to be applied to meat instead of smoking them, is prohibited.

TESTING SMOKED MEATS

Sourness in smoked pork can often be detected when the warm meat is removed from the smokehouse, and often a taint will be noticeable a week or two after smoking, but most of the meat that has safely reached this stage may be considered sound. A ham trier may be used to test each piece. This instrument resembles a narrow 10-inch harness awl. A length of stiff wire sharpened at one end may also be used. This trier is run along the bone to the center of the ham from both hock and loin ends. If the trier brings out a sweet, smoky odor, the meat is sound. If upon withdrawal the trier carries an unpleasant odor, the piece should be cut open and examined carefully for spoilage. If there is a definite odor of putrefaction, it is best to destroy the entire piece. Shoulders are tried in the shank, at the shoulder point, and under the bladebone.

WRAPPING AND STORING SMOKED MEATS

After the smoked meat has cooled it is ready to be wrapped and stored. Many farmers rub pepper on the meat at this time to add flavor. Ground black pepper, with or without a little red pepper, may be used. The meat is then well covered with parchment paper and put into muslin bags. The paper wrapping should be heavy enough to keep the grease from soaking the bottom of the bag. The tops of the bags should be folded over and tied securely, a loop for hanging the meat being made in the outside tie string. Each sack may be further protected by being painted with yellow wash, and then hung up for future use. In preparing the yellow wash, for 100 pounds of hams or bacon use the following: Three pounds of barium sulphate, $1\frac{1}{4}$ ounces of yellow ocher, 1 ounce of glue (dry), and 6 ounces of flour.

Fill a pail half full of water and mix in the flour, breaking up all lumps thoroughly. Mix the ocher in a quart of water in a separate vessel, add the glue, and pour them into the flour-and-water mixture. Bring this mixture to a boil and add the barium sulphate

slowly, stirring constantly. Make the wash the day before it is required. Stir it frequently while using it and apply it with a brush. Lime, clay, flour, or a similar substance mixed with water to a rather thick consistency, may also be used to paint the bags.

The date for killing and curing should be so planned that the smoked meat can be bagged or put in an insect-proof place before the flies appear in the spring.

If the meat has been properly cured and smoked it should store satisfactorily in a dry, dark, cool, well-ventilated place. Many farmers keep their hams and shoulders a year or longer until they have developed the pungent flavor characteristic of stored smoked pork.

In humid climates mold may develop very rapidly on the meat but usually can be rubbed or trimmed off without serious loss. Meat should be closely watched for evidence of mold penetration into the body of the meat. Once the mold works in between the muscles it injures the flavor of the meat.

The shrinkage of dry-cured hams and shoulders, just after being smoked, will range from about 8 to 15 per cent of their fresh weight, and of brine-cured hams and shoulders, from 3 to 8 per cent. At the end of 12 months' storage the shrinkage of either may reach 20 to 30 per cent.

Bacon is usually more palatable when freshly cured and smoked. It does not store so well as hams and shoulders, and most farmers prefer to use it during the spring and early summer.

RENDERING LARD

Ordinarily the leaf fat, back fat, and fat trimmings are cooked together. The caul and ruffle fats from the offal yield a darker product than the other fats. If the offal fat has been removed carefully and washed and chilled promptly, it should have an acceptable odor and flavor.

Lard will render more rapidly and completely if it is cut into small pieces before being put into the kettle. Many persons prefer to grind it. The kettle should not be too full or it may boil over. From one-fourth to one-half pound of baking soda added to 500 pounds of fat when rendering is begun will darken the cracklings but whiten the lard. To prevent sticking and scorching, the fat should be stirred frequently and the fire should be watched during the entire cooking process.

Cooking should be very slow until the fat has begun to melt and the mass can be stirred freely in the kettle. At the beginning of the process, the temperature of rendering lard will be about 212° F. As the water contained in the fat tissues evaporates the temperature will rise slowly until it reaches 240° or 255°, which is as high as it should be allowed to go.

As rendering proceeds the cracklings will brown and float. When they are more nearly completely rendered they will gradually sink to the bottom. Care should be taken at this time to prevent small particles of dried-out cracklings from scorching on the bottom of the kettle. Many persons stop the cooking when the cracklings are still floating. The more nearly complete rendering, however, removes a greater proportion of the moisture, thus producing lard that will be more likely to keep.

It is advisable to allow the rendered lard to settle and cool slightly before emptying the kettle. The liquid lard may be siphoned or dipped carefully into containers. The rest of the lard, containing the cracklings, is usually put through a lard press, the lard being strained through a screen covered with two or three thicknesses of cheesecloth. If the hot lard can be put into 5 or 10 pound containers and stored immediately at temperatures near or below freezing, it will chill rapidly enough to produce a fine grain.

Leaf fat will yield from 90 to 93 per cent of its weight in rendered lard; a combination of leaf fat, back fat, and cutting fat, from 80 to 85 per cent; and offal fat, from 55 to 65 per cent. Well-pressed, skinned cracklings from an average kettle will constitute 4 to 6 per cent of the original weight of the fat.

STORING LARD

Air and light may cause a chemical change in stored lard which results in rancidity. For this reason the containers should be filled as nearly to the top as possible, sealed with a tight cover, and stored in a dark, cool place. Once the lard has become rancid it is impossible to improve it.

If the moisture has been eliminated from the lard by a thorough rendering, no water-souring should develop during storage.

MAKING SAUSAGE AND RELATED PRODUCTS

Sausage may be made one of the most desirable and appetizing of all pork products. Often the shoulder, bacon strip, and even the loin and hams are made into sausage along with the trimmings. There are many kinds of sausage, for each of which the seasoning may be varied to suit the individual taste. The few recipes included here are offered mainly as a guide. Desirable sausage can be made only from sound, high-quality materials. Care and accuracy in proportioning the ingredients are also essential.

The sausage grinder should be equipped with two combs or plates, having $\frac{1}{2}$ and $\frac{1}{8}$ inch holes respectively. A small hand stuffer will be convenient.

Some sausage, such as fresh pork sausage and headcheese, may be used without being stuffed, but those similar to liver sausage and Bologna-style sausage should be stuffed in casings. Bundles or sets of salted casings may be purchased from almost any butcher. Several types of manufactured casings are also on the market. Muslin casings about 2 inches in diameter may be made by stitching together the sides and one end of a muslin strip 6 inches wide. The muslin casing should be moistened in water before being used and the salted casings soaked for several minutes in warm water and then flushed out. Sausage stuffed in muslin casings is frequently paraffined after it has been chilled.

In stuffing, force enough sausage into the stuffer attachment to fill it. Slip as much soaked casing over the attachment as it will hold. If muslin casing is used, pull the closed end of the casing up tightly against the end of the stuffing tube. These precautions prevent the formation of air pockets in the sausage.

The operator supports the casing at the end of the stuffer with the first finger of his left hand while he turns the crank with his right hand. Pressing upward with the left forefinger and raising the stuffed casing above the end of the stuffer will pack the casing more tightly, thereby keeping out air pockets. Animal casings are cut after the proper-sized ring or length has been stuffed and a new length is then begun.

To tie the casings, drive a 10-penny nail into the far corner of the table and fasten to it one end of a stout, soft, white string 3 feet long. Grasp both cut ends of the casing, for example, a ring of liver sausage, in the left hand and tie them together with two half hitches of the string. Tie the first ring near the nail and each succeeding one a little farther down the string. When the string is full, cut it free and attach a new one.

FRESH SAUSAGE

The fresh trimmings from which pork sausage is made should be about one-third fat and two-thirds lean. If more fat is included, the sausage may be too rich and will have a large cooking loss. Less fat will make the cooked patties rather hard and dry and difficult to brown.

In making a small quantity of sausage to test the recipe, the following measurements may be used:

- 4 pounds trimmings.
- 5 level teaspoons salt.
- 4 level teaspoons ground sage.
- 3 level teaspoons ground pepper.
- $\frac{1}{2}$ level teaspoon ground cloves or
- 1 level teaspoon ground nutmeg (if desired).
- 1 teaspoon sugar.

For 100 pounds of trimmings use the following:

- $1\frac{3}{4}$ pounds salt.
- 2 to 4 ounces ground sage.
- 2 to 4 ounces ground pepper.
- $\frac{1}{2}$ to 1 ounce red pepper (if desired).
- $\frac{1}{2}$ to 1 ounce ground cloves, or
- 1 ounce ground nutmeg (if desired).
- 12 ounces of sugar may also be included if the sausage is to be used reasonably soon.

The seasoning should be well mixed, spread over the trimmings, and the whole quantity ground through the fine plate. Some persons prefer to grind the unseasoned meat through a plate with $\frac{1}{2}$ -inch holes and then mix it with the spices and regrind through a plate with $\frac{1}{8}$ -inch holes.

If the sausage is to be put into casings it should be stuffed immediately after grinding. It should then be soft enough to pack tightly in the casings without the addition of cold water. It may also be fried down or canned.

To make bulk sausage that will slice and fry without crumbling, add a scant half cup of cold water to each 4 pounds of ground seasoned sausage and knead with the hands until the meat becomes very sticky and doughlike. Pack tightly in small molds or pans and allow it to chill before slicing it.

SMOKED SAUSAGE

Use pork sausage made with 2 pounds of salt, instead of $1\frac{3}{4}$ pounds, per 100 pounds of trimmings. If it is too stiff to stuff properly, add from 3 to 5 per cent of cold water and knead until the mass becomes doughlike. Stuff tightly in casings and allow it to cure for about 24 hours in a cool place. Smoke and dry at a temperature of 70° to 90° F. for a day or two until a dark mahogany color is obtained. This sausage should not be kept until hot weather unless it is canned.

BOLOGNA-STYLE SAUSAGE

Bologna-style sausage consists of ground pork and beef mixed with enough water to give the sausage the desirable fine, tenacious texture. Commercial concerns grind warm beef from freshly slaughtered cattle with cracked ice because this method gives a still finer grain to the finished product.

One standard recipe for Bologna-style sausage is as follows:

60 pounds beef.
40 pounds pork trimmings.
20 pounds cold water.
2 to $2\frac{1}{2}$ pounds salt.
2 to 4 ounces black pepper.
1 to $1\frac{1}{2}$ ounces coriander.
1 ounce mace.
Onions (if desired).

Grind the chilled beef trimmings with salt at the rate of 2 pounds per 100 pounds of beef. Use the coarse grinding plate, and allow the meat to cure in a cool place for about 48 hours. Salt, in the same proportion, is added to the coarsely ground pork the next evening and the pork is allowed to cure overnight. Many persons do not cure the pork.

Reground the cured beef, using the plate with $\frac{1}{8}$ -inch holes. Then add the pork and grind the mixture again. If the pork was not cured add the salt (13 ounces for 40 pounds) before grinding. Add the spices and the water and stir or mix vigorously until the whole mass has become sticky. Thirty minutes is often needed to mix this sausage properly.

Stuff the sausage tightly into beef or muslin casings and allow it to hang in a cool place until the next morning. Put it in a well-ventilated smokehouse heated to 110° to 120° F. Protect the casings from a direct blaze that might scorch them. The sausage should take on a rich mahogany brown in about two hours' smoking.

Put the hot, freshly-smoked sausage immediately into water heated to 160° to 175° F., and cook it until it squeaks when the pressure of the thumb and finger on the casings is suddenly released. The usual cooking time for sausage stuffed in beef "rounds" is 15 to 30 minutes, for larger casings 60 to 90 minutes. Plunge the cooked sausage into cold water and chill it. Hang it in a cool place.

COOKED PRODUCTS

Cooking is a convenient means of preparing the edible parts of cuts that are difficult to bone, such as the head, feet, and tail. It is also a means of utilizing miscellaneous pieces of trimmings, liver, heart, tongue, skin, and the soup in which the meat has been cooked.

All meat should be well trimmed and washed before being cooked. The teeth, nasal passages, eyes, and eardrums should be removed. If the lips, snout, and ears have been well cleaned, they may be included. The jowl is usually cut off and cured. It may be added, but will often cause the headcheese and scrapple to be too greasy.

The feet should be well shaved and cleaned and the glandular tissue between the toes trimmed out. If the lard fat has been skinned, the clean strips of skin add gelatin (binder) and flavor to the sausage.

HEADCHEESE

Headcheese is the most simply made of the cooked sausages. Make deep cuts in the jowls or other thick pieces of meat, cover with water, and simmer until the meat is well done and slips easily from the bones. The skin, if used, should be cooked in a net or sack so that it may be removed when so tender that a finger can be pushed through it. The thick ears and snouts will require longer cooking than the other skin. The skin is ground with the plate having $\frac{1}{8}$ -inch holes. The jowls and other pieces are boned after being cooked. These, with the boneless pieces such as the heart, are ground with a plate that has $\frac{1}{2}$ -inch holes. Some persons prefer to cut the tongue and some of the larger pieces of fat into strips instead of grinding them.

The finely ground skin and coarsely ground pieces are then mixed with enough of the soup—the water in which the meat was cooked—to make the mass soft without being sloppy. This mixture is returned to the kettle and brought to a good boil. This reheating serves to mix the gelatin thoroughly through the soup so that when the headcheese is poured into shallow pans and chilled it will slice without crumbling.

Seasoning is added at the beginning of the second cooking. Usually it is safe to season to taste though the following quantities of seasoning per 100 pounds of cooked meat, including the added soup, are a satisfactory guide:

- 2 to $2\frac{1}{2}$ pounds salt.
- 3 to 5 ounces black pepper.
- $\frac{1}{4}$ to 1 ounce red pepper (if desired).
- 1 ounce ground cloves (if desired).
- 1 ounce coriander (if desired).
- 2 ounces sweet marjoram (if desired).

If headcheese is stuffed into casings, it should be seasoned and stuffed before the second cooking. The stuffed headcheese should then be replaced in the remaining soup and simmered until it floats. This will require from 10 to 30 minutes. It is then chilled in cold water and stored in a clean, cool place.

Headcheese is usually eaten cold, sometimes with vinegar.

LIVER SAUSAGE

Cook heads, tongues, skins, hearts, and other pieces as for headcheese, but for a shorter period. Remove from the fire when the cuts can be boned. Scald the livers last. If they are deeply cut

with a knife they should be sufficiently seared in about 10 minutes. Liver adds a definite flavor to this sausage: 10 to 20 per cent of liver, by weight, is usually added to the other cooked products.

Grind all the cooked materials moderately fine and add about one-fifth as much soup by weight, using enough soup to make the mixture soft but not sloppy. Season to taste and mix thoroughly. The following are standard quantities of seasonings for 100 pounds of the mixture:

- 2 to 2½ pounds salt.
- 2 to 4 ounces black pepper.
- 1 to 3 ounces sage (if desired).
- ¼ to 1 ounce red pepper (if desired).
- 1 to 2 ounces allspice (if desired).

The seasoned, well-mixed sausage is usually stuffed in beef casings and simmered in water until it floats; usually the time required is 10 to 30 minutes. After being cooked, the sausage is plunged into cold water, chilled for at least 30 minutes, and hung up to drain.

If the meat is cooked too much in the first kettle, the second cooking, after the sausage has been stuffed, will destroy the tight "live" texture of the finished sausage.

SCRAPPLE

Scrapple, an especially favored breakfast dish in many sections, is composed of cooked pork and soup thickened with corn meal, flour, and sometimes shorts.

Cook the heads, hearts, and trimmings as for liver sausage, or until the bones can be removed. Cook the skin, if used, until tender. Grind all the material through the fine plate. Return all the ground material to the soup after it has been strained to remove the bones, and bring it to a boil.

The cereal mixture to be added may vary widely. One consisting of 7 parts corn meal and 3 parts white or buckwheat flour or 7 parts corn meal, 2 parts shorts, and 1 part buckwheat flour, should be acceptable.

Four parts ground cooked meat products, 3 parts soup, and 1 part dry cereal mixture (by weight) will produce a richly flavored, satisfactory scrapple. More meal and soup may be used if desired.

In adding the cereal mixture, moisten it with some of the cooled soup so that it may be added to the hot soup without forming lumps. Boil it for about one-half hour, stirring it frequently or constantly to prevent sticking. Add the seasoning shortly before the cooking is finished and stir it in well.

The following seasonings may be used for 100 pounds of scrapple, including the soup and the dry cereal mixture:

- 2 to 2½ pounds salt.
- 2 to 4 ounces black pepper.
- 2 to 4 ounces sweet marjoram.
- 2 to 4 ounces sage (if desired).
- 1 ounce red pepper (if desired).
- 1 ounce nutmeg (if desired).
- ½ ounce mace (if desired).
- 2 pounds ground onions during second cooking (if desired).

The hot scrapple is poured into small shallow pans and chilled as quickly as possible. If properly made it can be sliced and fried quickly without much crumbling. The slices may be dipped in egg before they are fried.

PANHAS

The soup remaining after the making of headcheese or liver sausage may be used to make a kind of corn-meal mush called "Panhas." Strain out all bones, bring the soup to a boil, and add the meal slowly. A safe method of preventing the formation of lumps is to moisten the meal beforehand with a little cooled soup, adding enough of the liquor to make a thick paste.

Three or four parts of soup to one part of meal, by volume, is a good proportion. Season to taste with the seasonings given for headcheese. Cook the meal 30 to 45 minutes and pour it into shallow pans to cool. Slice and serve like scrapple.

CANNING PORK

Pork should be canned in a steam-pressure cooker at a pressure of 15 pounds (250° F). Water-bath, live-steam, oven, and open-kettle methods of canning will produce a temperature of only about 212° F., which is too low to sterilize meat thoroughly.

Use only meat which is fresh and in good condition. Wipe the meat with a damp cloth, and remove the excess fat and the bones. Cut into pieces of suitable size to be placed in the containers to be used. Heat the meat thoroughly, until it is no longer red, by simmering it in water or by placing it in an oven. Pack it into the containers while it is hot, and work rapidly. Pour enough liquid over the meat to fill the container within one-half inch of the top; use the broth in which the meat had simmered, or the pan drippings, if they are not dark brown, diluted with boiling water. Add salt as desired (about 1 teaspoon per pint). Completely seal tin cans at once or partly seal glass jars, and place them in the pressure cooker immediately, before the meat is cooled. Process at 15 pounds' pressure as follows:

	Minutes
Pint glass jars.....	60
No. 2 plain tin cans.....	50
No. 2½ and No. 3 plain tin cans.....	60

When using No. 2 and No. 2½ tin cans, open the petcock on the pressure cooker as soon as the processing period is over and allow the steam to escape. Open the cooker and place the cans in cold water. Use running water if it is available; otherwise change the water frequently until the cans have cooled.

When using No. 3 tin cans or pint glass jars, allow the steam gauge to come to zero before opening the petcock. Then open it gradually to prevent a sudden outrush of steam. Too rapid lowering of pressure surrounding the jars will draw the liquid out of the jars.³

³ General information on the preservation of food by canning and details of processing food in the pressure cooker are given in Farmers' Bulletin 1471, Canning Fruits and Vegetables at Home. This bulletin should be used to supplement the directions given. More detailed directions for the canning of pork may be obtained from the Bureau of Home Economics, U. S. Department of Agriculture.

REGULATIONS FOR SHIPPING MEAT OR MEAT FOOD PRODUCTS

Farmers who ship their meats must comply with official State and Federal regulations. Below is shown a sample shipper's certificate such as must be used in interstate shipments of uninspected meat or meat food products which are from animals slaughtered by the farmer on the farm. Blank certificates should follow this sample. In size the certificate should be 5½ by 8 inches.

SHIPPER'S CERTIFICATE

Date _____, 19__

Name of carrier _____

Shipper _____

Point of shipment _____

Consignee _____

Destination _____

I hereby certify that the following-described uninspected meat or meat food products are from animals slaughtered by a farmer on the farm, and are offered for transportation in interstate or foreign commerce as exempted from inspection according to the act of Congress of June 30, 1906, and at this date they are sound, healthful, wholesome, and fit for human food, and contain no preservative or coloring matter or other substance prohibited by the regulations of the Secretary of Agriculture governing meat inspection.

Amount and weight.

Kind of product _____

(Signature of shipper)

(Address of shipper)

Two copies of this form are to be presented to the common carrier with each shipment.

COOK PORK THOROUGHLY

THROUGH eating raw pork man may become infected with a very serious disease called trichinosis. The lean meat of hogs may harbor parasites called trichinae which are too small to be seen with the naked eye. The danger of trichinosis can be entirely avoided by thoroughly cooking the pork. Certain pork products, however, that are intended to be eaten without cooking may be considered safe if they bear evidence of Government inspection or equally competent State or local inspection.

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41.9.
No. 1186

PORK

ON THE FARM

Killing, Curing,
and Canning

FARMERS' BULLETIN No. 1186
U. S. DEPARTMENT OF AGRICULTURE

WARM, freshly slaughtered pork carcasses should be chilled to a temperature between 34° and 40° F. within 48 hours, preferably within 24 hours, after slaughtering. Bacteria which may cause spoilage if their growth is not promptly checked by chilling are often present in the meat.

Meat as it cures will normally develop a more uniform, desirable flavor if it can be held at an even temperature of about 38° F. On the farm, temperatures are not easily controlled, but every effort should be made to approximate those mentioned.

Proper slaughtering equipment will make it possible to clean hog carcasses thoroughly so that full use can be made of all the parts, including the head and feet.

Sausage, scrapple, headcheese, and similar products afford means of utilizing certain parts of a hog carcass that might otherwise be wasted.

Clean, well-cut, smoothly trimmed meat can be cooked and used to better advantage than pieces that have been soiled or improperly prepared.

Washington, D. C.

Issued February 1921
Revised October 1928

PORK ON THE FARM

Killing, Curing, and Canning¹

By K. F. WARNER, *senior extension meat specialist, Animal Husbandry Division,
Bureau of Animal Industry*

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IMPORTANCE OF PROPER METHODS

SINCE FRESH MEAT is highly perishable, proper handling is necessary to make it into sound and palatable products that will keep satisfactorily. Only through the elimination of waste and spoilage can the advantages of dressing hogs on the farm be realized. Success in preparing meat depends upon strict attention to the methods used. None of the details of these methods are difficult, but all are important.

There are many different ways in which to prepare pork products. The most desirable one for each farmer is that which best suits his family or locality. However, certain general rules for cutting and curing should be observed by all.

EQUIPMENT

Elaborate and expensive equipment is unnecessary, but certain tools are essential and others are very desirable (fig. 1). Most useful of all is the curved 6-inch skinning knife. It may be used for sticking the hogs, raising the gambrel tendons, shaving and dressing the carcass, and cutting and trimming the meat. It is also the best knife for skinning cattle and lambs. Once the user becomes ac-

¹This is a revision of a previous edition written by F. G. Ashbrook, junior animal husbandman, and G. A. Anthony, lay inspector, Bureau of Animal Industry, and Frants P. Lund, Division of Cooperative Extension.

customed to its shape, the curved knife will be found to cut more easily and smoothly than the straight butcher knife. A narrow-bladed boning knife, the narrower the better, is needed in preparing boneless roasts and boning meat that is to be made into sausage or canned.

In sharpening a knife a grindstone commonly is used first. With it an even bevel, about one-fourth inch wide, is put on each side of the blade. An oilstone is used to give a smooth, keen edge. A smooth, high-quality, 9- to 14-inch steel is used to keep a sharp knife in good cutting condition. A smooth steel straightens the edge of a sharp knife or removes the "set" from the microscopic teeth that compose the edge. When they are purchased, most steels, even those of high quality, are too rough to be serviceable and should be rubbed down with an emery stone until the surface is smooth and glassy. One can form the habit of steeling the knife briefly but frequently while using it.

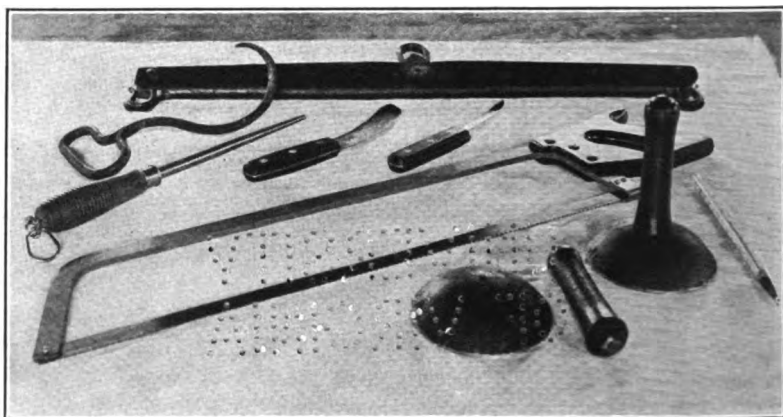


FIGURE 1.—Equipment for use in slaughtering and dressing hogs: Gambrel (singletree) hook, smooth steel, skinning knife, boning knife, saw, bell-shaped hog scrapers, and thermometer.

The meat saw should be 24 to 28 inches long. A saw of this length can be used instead of a cleaver for splitting either hog or cattle carcasses. The bell-shaped hog scrapers are the best hand instruments yet devised for removing the hair, scurf, and dirt. A fairly heavy steel scraper, with a bell that will take a rough edge on the outside when rubbed with an emery stone or file, is the most efficient. A scraper 4 inches in diameter can be used more easily than larger sizes, whereas smaller scrapers are usually too light and do not hold their shape. A clean singletree with open hooks makes a more desirable gambrel for hanging the carcass than the customary notched stick as there is less danger of the carcass slipping off the singletree. When many hogs are to be killed, the use of commercial metal gambrels is suggested.

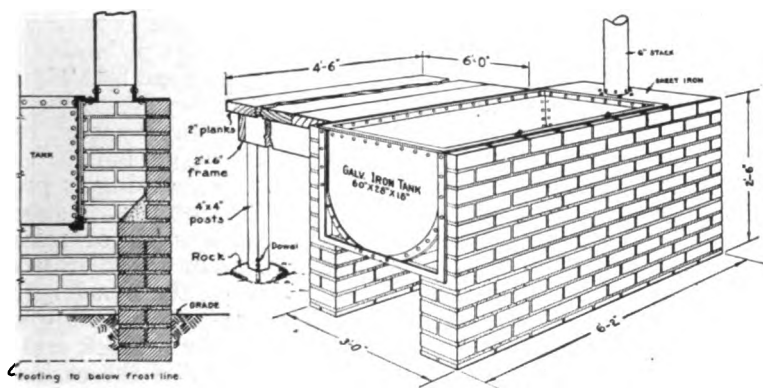
A 50-gallon hardwood or metal barrel will serve to scald a hog weighing up to 250 pounds, without much difficulty. A metal trough or watering tank 5 to 6 feet long, 30 inches wide, and 15 to 24 inches deep may be converted into a combination water heater and scalding vat. It is set up on bricks or put over a trench. The sides are banked with earth and a fire built beneath (fig. 2). This arrange-

ment permits holding the temperature of the water at the proper point for scalding any number of hogs.

The most convenient scraping table is $4\frac{1}{2}$ feet wide, $2\frac{1}{2}$ feet high, and 4 to 8 feet long (fig. 2). On a table of this width the hog can be laid crosswise so that one man may scrape the rear end while the other scrapes the head. A thermometer that will register up to 212° F. is desirable so that the temperature of the water can be correctly gaged.

A hog or hay hook for use in scalding the animal; pans or tubs for holding edible and inedible viscera; a block and tackle, ladder, rack, or other means for suspending and chilling all the carcasses that are to be dressed; and plenty of hot and cold water should be provided before operations begin. A small blowtorch and wire brush will help materially in singeing and scrubbing the head and feet.

A salinometer (known also as a salimeter), operating on the same principle as the wet-battery hydrometer, may be used in measuring



SECTION THROUGH SMOKE CHAMBER

PERSPECTIVE

FIGURE 2.—Combination water heater, scalding vat, and scraping table. The tank may also be set on the ground over a trench and banked with sheet metal or earth.

accurately the saltiness of the curing brine. It is inexpensive, and may be obtained at any butcher's supply house.

MEDIUMWEIGHT HOGS MOST DESIRABLE FOR SLAUGHTER

A hog weighing from 180 to 225 pounds alive will produce moderate-sized cuts and usually a very desirable proportion of fat and lean. Heavier hogs will produce more lard.

When hams and shoulders are cut according to the methods later described, each will weigh about 7 percent of the live weight of the hog. Each bacon strip and loin will weigh about 5 percent and the head 7 percent. The weight of lard rendered from a 200-pound live hog will range between 9 and 13 percent of the live weight of the hog; and that from a 250- to 300-pound hog, between 14 and 18 percent.

A smooth, moderately well-finished hog will usually produce a desirable quality of meat. Of course the animal should be thrifty, and healthy and the meat suitable for human consumption.

CARE OF THE HOG JUST BEFORE SLAUGHTER

The care of an animal just before it is slaughtered has much to do with getting a good "stick." This is very important because meat from a well-bled hog keeps better than that from a hog which has not bled well. A hog bleeds more thoroughly and dresses more easily after a 24-hour fast, but it should be given all the water it will drink. Running the animal or wrestling with it often causes a temporary fever. If the animal is killed in this condition, the meat is likely to be bloody, sometimes referred to as fiery. Such meat looks bad and spoils easily. Bruises and whip marks cause bloody spots, which must be trimmed out. Penning the animal by itself the day before butchering is recommended.

STICKING

Killing the hog should be done as humanely as possible and in a way that will insure a thorough drainage of the blood. Putting the hog in a small pen the day before will make it easier to stun or catch without exciting it. Stunning may be done by striking one sharp blow with the head of an ax or other heavy blunt instrument or by shooting at a point in the forehead midway between the eyes and slightly above. Improperly placed blows or bullets that do not stun can cause the animal much pain. If stunning is practiced as a humane measure, take care that the first attempt is successful. Since bullets sometimes glance from a hog's skull or miss, care should be taken to prevent injury to persons or to other livestock.

If the animal is stuck without being stunned, the blood will drain out more completely than if it is stunned first. Shackling a hog's hind leg with a chain or rope and hoisting it by a block and tackle fastened securely some 10 feet above the ground is the easiest way, for both man and hog, to restrain the animal for sticking without stunning. To get the hog in proper position for sticking on the ground, reach under the animal and grasp its opposite front leg, then roll it upon its back and hold it firmly by the front feet. The man holding the hog stands astride it, facing forward, with his feet and knees pressed against the shoulders of the animal to prevent it from rolling (fig. 3).

The following sticking method is recommended for the beginner. The man doing the sticking takes a position squarely in front of the hog, holds down the snout, and opens the skin for a distance of about 3 inches in front of the breastbone. He then inserts the knife, edge downward, straight in toward the breastbone, not downward as is often done. When the breastbone is reached, he follows downward with the point of the knife until the knife slips under the breastbone and between the ribs. He then pushes the knife in about 1 inch and directs the cut first downward toward the backbone, then forward toward the head (fig. 4). Care should be taken to hold the animal squarely on its back and to keep the knife in the center so as not to stick a shoulder. It is both difficult and unwise to stick the heart. Let it pump out the blood as long as possible.



FIGURE 3.—Sticking the hog. Note that the feet of the man holding the hog are pressed against the shoulders of the animal to prevent its rolling.

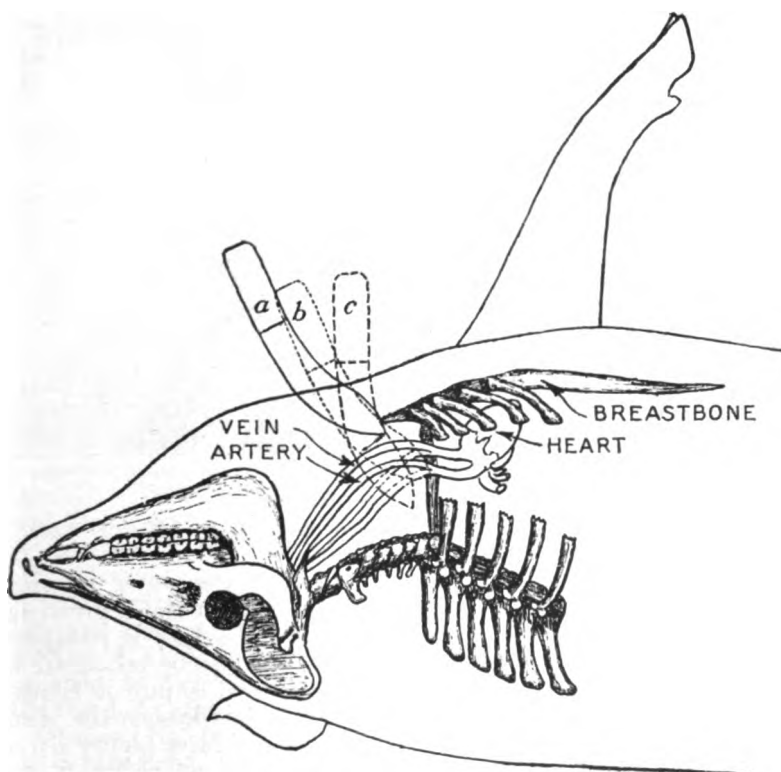


FIGURE 4.—The three positions of the knife in sticking a hog: *a*, The knife inserted in the fat; *b*, the second position places the knife above the artery; *c*, the final position, after the downward thrust has been made and the artery severed.

SCALDING

Slow scalding is usually best. At slaughterhouses where steam is available to maintain the scalding water at a steady temperature, the water is usually held at 140° to 144° F. With these temperatures it will take from 3 to 6 minutes to loosen the hair and scurf, but there is little or no danger of setting the hair or cooking the skin. In the fall of the year when the winter hair is beginning to grow and most



FIGURE 5.—Scalding the hog. Keeping it in motion lessens the danger of setting the hair and works the water into the wrinkles of the skin.

hogs are difficult to scald, temperatures as high as 146° to 150° are sometimes used.

On the farm, where it is difficult to reheat the water promptly, temperatures of 155° to 165° often must be used at the beginning so that the water will not become cold before the hog is completely cleaned. In using water as hot as this, care must be taken to keep the hog in motion (fig. 5) while in the water and to pull it from the barrel and give it frequent chances to cool. This lessens the danger of setting the hair. If possible, it is advisable to have plenty of boiling water available so that lower temperatures can be used at the beginning and more hot water added if necessary. The combina-

tion heater and scalding vat shown in figure 2 is the most convenient means for obtaining the proper temperature.

Lime, rosin, or other substance that will make the hair cling to the scraper and pull out more easily is often put into the water. The proper temperature of the water, however, is more important than any substance that can be put into it.

Twenty-five to thirty gallons of water is ordinarily enough to scald a hog in a 50-gallon barrel. Lightweight or mediumweight hogs can be practically immersed in the barrel. The animal is held with a hook in the lower jaw. In scalding large hogs the ham end of the animal is immersed first and then the head end. When the latter end is immersed, one leg of the hog is held with the hook caught in the gambrel tendon. At this time, a third man, if available, can remove most of the hair from the hot legs and flanks even though the animal is kept in motion.

SCRAPING

When the hog is completely scalded, turn it crosswise on the table. One man should grip the hind legs with both hands and twist off the hair, then pull off the dew claws and toes, while hot, with a hook, and scrape the hindquarters (fig. 6). Another should scrape the hair from the forequarters, feet, and head. After some experience, one will learn to stretch the skin by moving the leg or head so as to smooth the wrinkles and make scraping easier. If patches of hair have not been thoroughly scalded, it is often possible to loosen them by covering them with sacks or hog hair and pouring hot water on them. The dehairing of the hot carcass should be done as rapidly as possible as there is a tendency for the skin to "set" and render the removal of the hair difficult.

After the hair and scurf have been scraped off, much of the dirt can be removed by rinsing the carcass with warm water and pressing the bell scraper flat against the carcass instead of tipping it on its



FIGURE 6.—In scraping the carcass tilt the scraper on its far edge and pull forward. Use both hands and plenty of pressure.

edge as before (fig. 7). A blowtorch and wire brush will now be very useful in singeing and scrubbing the head and feet (fig. 8).

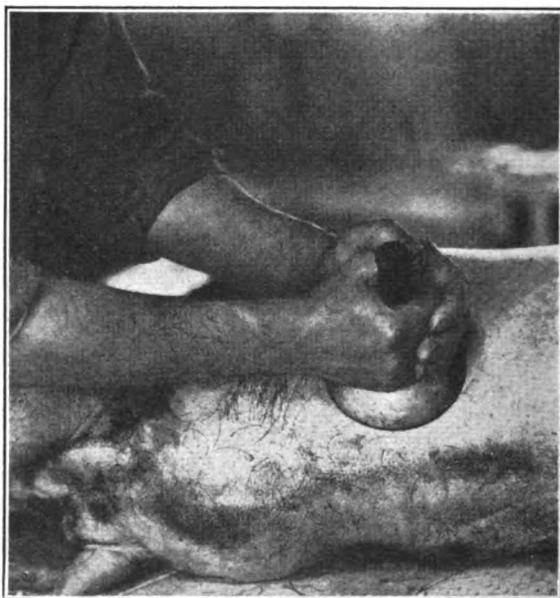


FIGURE 7.—To remove the dirt, press the scraper flat against the wet skin and move it rapidly back and forth. This creates a suction that will remove much dirt and stain.

The scraped, singed carcass is ready to be rinsed with cold water and shaved (fig. 9). Wash and shave the entire carcass. It is now ready to be hung up. To insert the gambrel, open the skin at the center of the hind leg just above the foot and directly over the tendons. Push the skin aside with the knife and cut down to the bone at the side of the tendons, as shown in figure 10. Make a similar cut on the other side of the tendons. Put the knife aside and raise the tendons with the fingers to receive the gambrel. Be sure the gambrel or

hook engages both tendons. After the gambrel is raised and the carcass is suspended, wash the carcass again with cold water and shave it again.

REMOVAL OF INTERNAL ORGANS

Opening a hog carcass and removing the internal organs are really very simple operations, particularly if the animal has been kept off feed for 24 hours before slaughter. There are many different methods, but the following should be easily understood by the beginner.

Insert the skinning knife, edge up, into the sticking place and cut up through the full length of the breastbone (fig. 11). If the breastbone is very hard to cut, as it may be in older hogs, the cut may be made a little to one side of the mid-



FIGURE 8.—Cleaning the head. The head is scraped and singed and then scrubbed with the wire brush.

breastbone (fig. 11). If the breastbone is very hard to cut, as it may be in older hogs, the cut may be made a little to one side of the mid-

dle where there is softer bone or cartilage. It is sometimes necessary to use the saw. Care should be taken not to extend the opening incision upward beyond the chest cavity. To do so will cut into the stomach or allow the intestines and stomach to protrude and interfere with the operation to follow.

Now begin at the other end of the carcass and cut down between the hams, taking care to keep the knife in the center. As the hams open, the white membrane which marks the exact middle can be seen. Follow this, if possible, to the pelvic bone. If one misses the middle "seam," correction may be made by a small bony projection that can be felt with the finger just underneath the front (forward side) of the pelvis. If the knife is

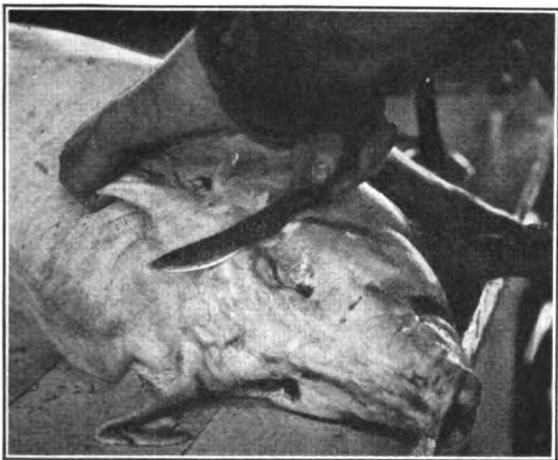


FIGURE 9.—In shaving the animal, stretching the ears, jowls, legs, and other parts will smooth out the wrinkles and make shaving easier.

directly above this projection, there is usually little difficulty in separating the hams correctly. Use the saw if necessary to divide the

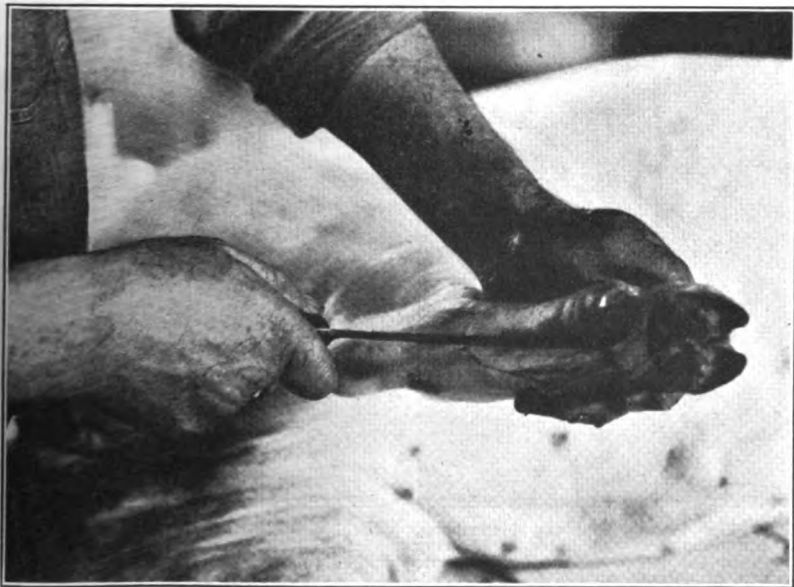


FIGURE 10.—Raising the gambrel tendon.

pelvic bone. While dividing this bone care should be taken to avoid puncturing the urinary bladder which lies just below. In dressing a

barrow, loosen the penis and let it hang, to be removed later with the bung. Insert the handle of the knife in the opening made in splitting the hams, with the point of the knife pointing outward.



FIGURE 11.—In splitting the breastbone. If the handle of the knife is slanting up with the point down there is little danger of cutting up too far and opening the stomach.

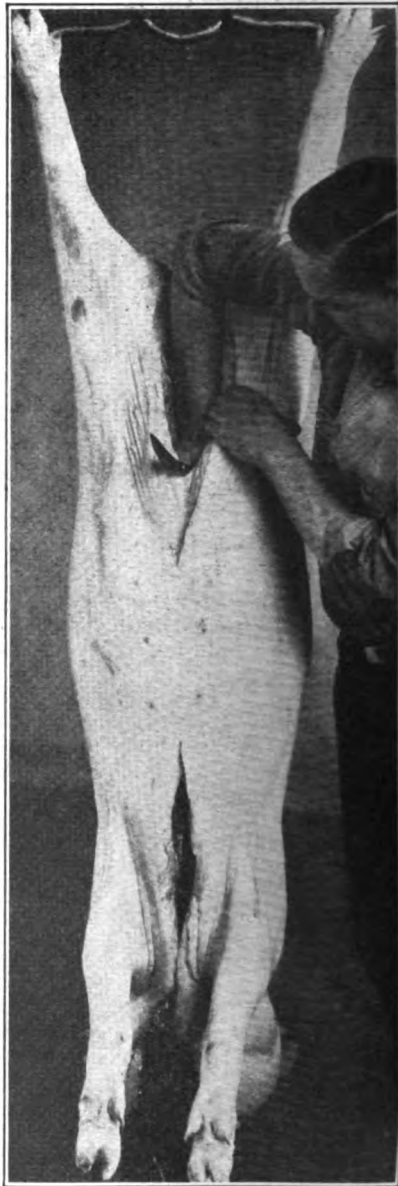


FIGURE 12.—Under this method of opening the carcass there is no danger of cutting the intestines or stomach.

Guard the heel of the blade with the forefinger and thumb of the right hand and cut down the median line of the belly until this cut joins the split breastbone (fig. 12).

Allow the intestines to roll out and hang by their natural attachments. Raise the bung by slipping the knife into the pelvic cavity and loosening the bung from the fat on both sides and at the back.



FIGURE 13.—The internal organs will not fall unless the animal was fed shortly before slaughter.



FIGURE 14.—In removing the intestines, grasp them carefully and firmly so they will not tear and fall.

Pull it down toward and past the kidneys. Be careful to cut it free from the kidney fat (fig. 13).

It is at this point that many inexperienced farm butchers expect to encounter trouble. The operation, however, is almost complete, and no difficulty need be anticipated. With the left hand grasp the

intestines firmly just below the kidneys at the point where they appear to be attached to the backbone. Push down slowly but firmly until they loosen from the back. Free the liver by running the fingers of the right hand behind it and pulling it away from the back. Still holding the intestines in the left hand, cut through



FIGURE 15.—The warm leaf fat is pulled out by loosening it at the rib end and fisting it up and out.

the diaphragm to the backbone (fig. 14). Extend the cut around the white fibrous portion of the diaphragm, which is parallel to the ribs, to the breastbone and down the breastbone to the throat. This last cut loosens the heart and lungs in the chest cavity. Still holding the intestines with the left hand, repeat the cut on the left side of the carcass, crossing the right hand over the left. It may sometimes be necessary to cut the back artery from the backbone, thus permitting the left hand to pull the entire offal out of the carcass. The gullet is still attached to the throat, but one cut of the knife will free it.

The body cavity should be washed and rinsed in cold water before the carcass is split. Splitting with a saw down the center of the backbone is recommended. This eliminates the savory country-style backbone piece or chine but gives a larger quantity of meat suitable for curing and canning.

The split carcass will chill more rapidly if the leaf fat is pulled out by loosening it where it is attached to the diaphragm at the last rib and stripping or fisting it up and

out (fig. 15). It is also much easier to remove the leaf fat when the carcass is hot than after it has been chilled.

In commercial practice, where carcasses are inspected, the head of the hog is unjointed before the carcass is opened. This operation requires a little skill but is readily learned. A cut is made about

one-half inch above the ear, at right angles to the backbone, and clear through the left jowl and top of the neck and throat. The left ear is held with the left hand, and the cut is made in to the backbone. This leaves the head hanging by the bone and right jowl. The cut should meet the neck joint where the first neck bone joins the head. The dished "button" end of the backbone fits over the head end of the joint in the same manner that the fingers and palm of one hand can be made to enclose the clenched fist of the other. The knife loosens the membranes at the lower or head end of the joint, the end of the "fingers" of the upper or enclosing "hand." As the joint opens, the knife moves upward along the "knuckles" of the clenched "fist," across its top, and down the far side. The whole joint is about $1\frac{1}{2}$ inches wide. Packers often unjoint the head by cutting across above the ears, peeling off the jowls, and allowing them to remain upon the carcass.

CHILLING THE CARCASS

The tissues of many freshly slaughtered hog carcasses contain bacteria that are capable of spoiling the meat unless their growth is promptly checked. Packers have practically solved the problem of sour meat by chilling the fresh, warm carcass to a temperature of 34° to 36° F. within 24 hours after slaughter and by holding the meat at 36° to 40° while it is curing. On the farm, butchering should be done when the weather is as favorable as possible. When necessary protect the freshly slaughtered carcass from freezing by hanging it in a shed or wrapping it with a sheet; but storing the warm meat at high temperatures, particularly those above 40° , is often the cause of spoilage.

Unless care is taken the fat bellies and hams of warm, freshly slaughtered hogs often overlap each other during the cooling process, thus closing the body cavity to air circulation. Warm hogs, so hung, will frequently show spoilage the next day, even when held at low temperatures. Slight taint is often observed along the bacon strip when the hot, heavy, leaf fat is not removed. It is always wise to split warm hogs and to pull the leaf fat as soon as the internal organs have been removed.

Whole or half carcasses should be suspended to chill so that they do not touch. When hams touch each other, chilling is often delayed too long, and spoilage occurs. If warm carcasses are held at temperatures slightly above freezing overnight, the internal temperature of the hams will not always be below 40° F. the next morning. Cuts from such meat should be spread out during the second night to permit complete chilling. The need for prompt and thorough chilling of warm carcasses cannot be overemphasized.

Many communities in the South have access to local cold-storage plants with facilities both to chill the carcass and to store the curing meat. The warm sides are brought in immediately after slaughter, and the owner returns 1 or 2 days later to cut the pork and put the meat in cure in the drawer, box, or bin assigned to him. The fresh cuts, fat for rendering into lard, etc., are taken home. In some cases the cold-storage company does the cutting. When nights are fairly cool the hogs are often dressed in the afternoon and allowed to hang overnight. The meat is cut and trimmed the next

morning and the curing pieces taken to cold storage. Where a community cooperates with a cold-storage plant, nominal charges to the farmers can often be obtained.

If the weather becomes warm and no cold storage is available, the warm sides may be cut up and the individual pieces hung up to air and cool, or packed in cracked ice ($1\frac{1}{2}$ pounds of ice per pound of meat). Sometimes insufficiently cooled pieces are salted lightly with a dry-cure mixture and spread on a rack where they will have as much ventilation as possible. None of these methods are as safe or as satisfactory as storing the meat at the proper temperature, either natural or artificial.

CARE OF THE INTERNAL ORGANS

The liver should be cut free and the gall bladder removed. The small, upper end of the gall bladder can be lifted with the thumb and finger and the bladder peeled out. The heart is cut off through the auricles or "ears." The tongue is removed at its base. All three parts should be washed promptly in clean water. They

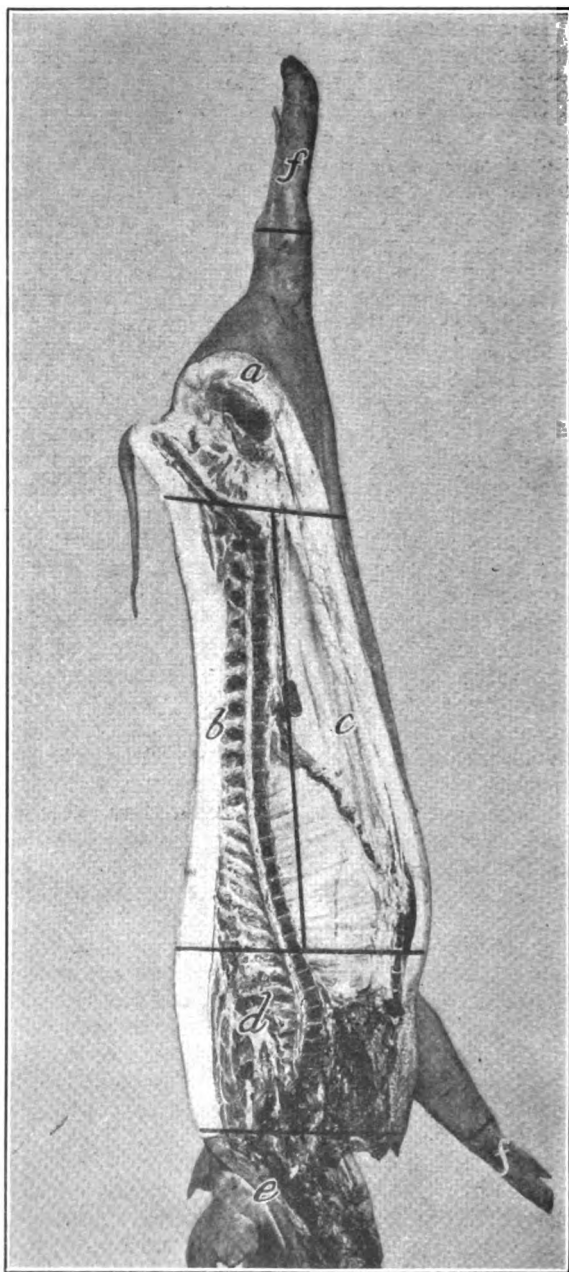


FIGURE 16.—Cuts of pork: *a*, Ham; *b*, loin; *c*, bacon strip; *d*, shoulder; *e*, head; *f*, feet.

may be chilled in cold water and hung up for further chilling and drying. The caul fat can be separated from the stomach with the

hands. The small intestines are removed or "run" from the ruffle fat by pulling the fat in one direction with the right hand and the intestines in the opposite direction with the left. The ruffle fat is then peeled off. This fat, if not fouled in dressing, should be saved for

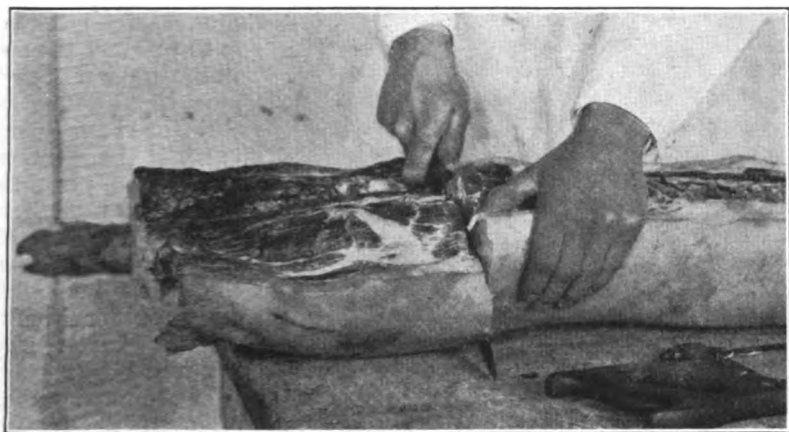


FIGURE 17.—Removing the three-rib shoulder.

lard. It should be thoroughly washed and promptly chilled in cold water. After being chilled, it is hung up to drain and dry before being rendered.

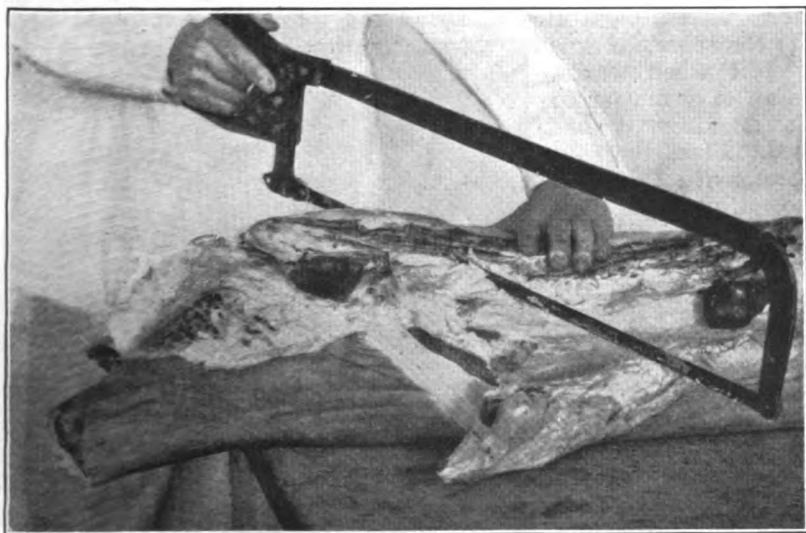


FIGURE 18.—In cutting off the square-top ham, saw at right angles to shank.

CUTTING THE CARCASS

There is no one best method of cutting a pork carcass. The choice depends on how the pork is to be used. If it is to be sold, the cuts should conform to local preferences. If the meat is to be preserved

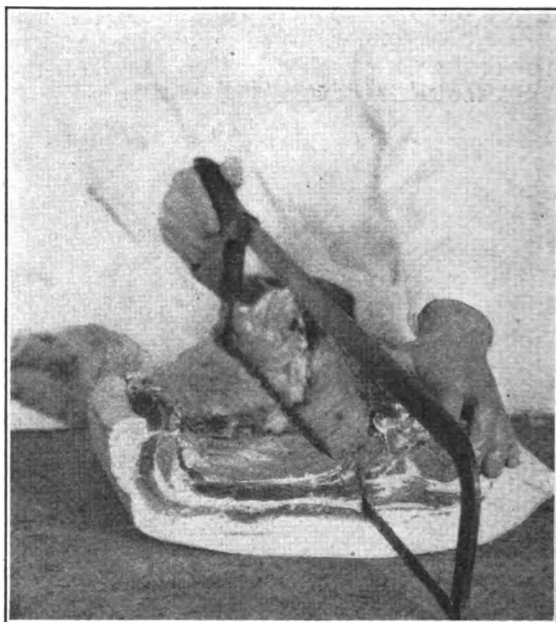


FIGURE 19.—In sawing the loin from the bacon strip, cut and saw through the leaf lard if it was not pulled off when warm.

by freezing, each piece should be of a size and character suitable for convenient cooking. The purpose of the method described here is to produce the maximum quantity of meat that can be cured and stored for summer use and the minimum number of parts that must be used fresh (fig. 16). This cutting method separates the thick ham, loin, and shoulder from the thinner bacon strip, fat, and head.

If the head was not removed in dressing, lay the carcass on its side and cut off the head about one-half inch behind the ears. Cut to the bone and

entirely around it. The head may then be twisted off at the neck joint.

If the carcass was not split when warm, it is an easy matter to split it after it has cooled. Place the cold carcass, with the head removed, upon its back with the hams extending beyond the table. Stand between the hams, and start the saw through the forward or shoulder end of the backbone. Saw from the inside toward the skin. As the shoulders are split, the two sides will spread apart, permitting more freedom in sawing the loin and last the hams.

A three-rib shoulder is removed by sawing between the third and fourth ribs parallel to



FIGURE 20.—Removing the back fat from the loin. One-fourth to one-half inch of back fat is usually left on the loin.

the head cut (figs. 16, *d*, and 17). A long ham is cut off just behind the rise in the pelvic arch and at right angles to the direction of the hind leg. The more popular short ham is cut through the second vertebra behind the rise. To make the desirable square-top ham, the saw should be at exact right angles to the shank (figs. 16, *a*, and 18).

Cut the thick loin (fig. 16, *b*) from the thin bacon strip (*c*) just below the curve in the backbone at the shoulder end and at the edge of the tenderloin muscle at the ham end. Lay the middle, skin side down, and saw across the ribs, as shown in figure 19. Remove the back fat from the loin by cutting down the side of the loin, as shown in figure 20, then raise the fat and loosen it down the center. There are three kinds of chops cut from the pork loin: Those from the shoulder end, the center cuts, and chops from the ham end. The whole muscle of the loin can be easily boned out for sausage or for canning. Unboned, it is suitable for chops and roasts. It may also be given a mild cure.

If the leaf fat is still on the bacon strip, cut it free along the rib end, loosen it by bending the bacon strip over the edge of the table, and then pull it out (fig. 21). In removing the spareribs the edge of the knife is kept against the ribs. This will leave most of the meat on the bacon strip (fig. 22).

The jowls may be cut from the head, trimmed, and cured. After the eyes, nasal passages, teeth, and incompletely cleaned parts of the ears and snout have been removed, the rest may be used with the liver, heart, and tongue for cooked products.

The lean in all trimmings should be saved for sausage. A proportion of two-thirds lean and one-third fat is the popular combination. Many persons prefer to remove the skin from the fat (fig. 23) before cooking the lard as the fat alone renders more satisfactorily. If the skin is clean, however, it need not be removed.

PICNICS AND SHOULDER BUTTS

The trimmed three-rib shoulder may be divided into a shoulder butt, a picnic (shoulder with much of the butt removed), and plate, if desired (fig. 24). The top third of the shoulder is cut off as the butt, the extra fat or plate being removed from the lean butt. This 2- to 4-pound butt makes a very acceptable fresh roast. If the butt is to be cured, the end of the shoulder blade is ordinarily removed and the boneless piece cured with the bacon. The plate may be cut up for lard or cured as salt pork with the fat back. The picnic or remaining shank end is trimmed or rounded evenly and cured with the hams and shoulders.

TRIMMING PORK CUTS

All meat to be cured should be trimmed smoothly and evenly. Care should be taken to remove all blood spots, to be looked for especially in the shoulder. The brisket and ragged neck pieces should be cut from the shoulder, the tail and flank from the ham, and the uneven edges from the bacon strip. Leave some fat as protection on the face or inside of the ham. Excess fat on hams and shoulders may be removed, though the pieces will store more satisfactorily in summer if not skinned. The bacon strip should be flattened out with the hands or with the side of a cleaver, and



FIGURE 21.—Bending the untrimmed bacon strip over the table edge to loosen the cold leaf fat.

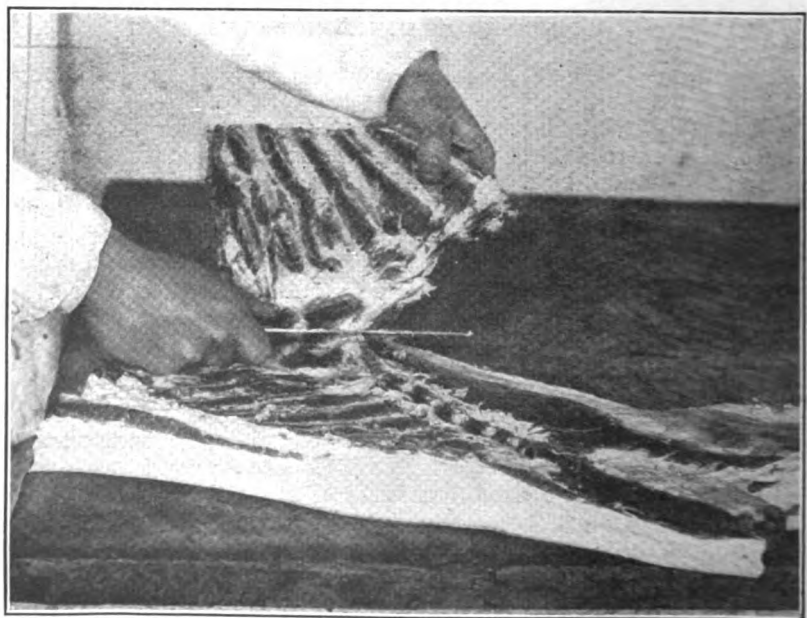


FIGURE 22.—Removing the spareribs from the bacon strip.

squared on all four sides. The jowls and fat backs, if these cuts are to be cured, should be treated in the same way. Spareribs and loins may be given a light cure without further trimming. Figure 25 shows the difference between poorly trimmed and properly trimmed hams, bacon, and shoulders.

FREEZING PORK

The widespread distribution of electric power and the development of so-called freezer-locker units (often referred to as refrigerated



FIGURE 23.—In skinning the fat trimmings, keep the knife parallel with the table and the edge turned slightly downward toward the skin.

lockers) have made subfreezing temperatures increasingly available to families interested in preserving farm-dressed pork. These units consist of individual compartments installed in a large room of a cold-storage plant. The compartments are made with wire-mesh sides or some material allowing free circulation of cold air. The doors of the compartments are fitted with locks so that each person may keep his products under lock and key.

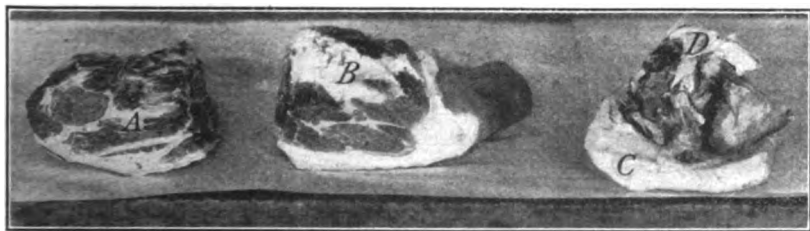


FIGURE 24.—A, Shoulder butt; B, picnic; C, plate; D, trimmings.

Freezing temperature is entirely practical for holding fresh pork though there are some definite limitations. The preserving effects of subfreezing temperatures include (1) killing or stopping the development of molds, yeasts, and bacteria, (2) reducing the activity of the enzymes, thus delaying autolysis or self-digestion, and (3) retarding chemical changes such as dehydration and oxidation. Although there is little microbial action under freezer storage, the development of undesirable textures, colors, odors, and flavors is common. These changes are attributed to the continuing action of the enzymes, evaporation of the surface ice, and other actions.

Ten degrees below 0° F. is generally accepted as the preferred temperature for the "sharp" freezing of meat products. Although 0° is the recommended level for storing frozen meat, 10° is often used and should be satisfactory if the lower one is not practical. Temperatures above 10° are, in general, too high. Much variation in temperature is undesirable.

Chilled pork should be cut into family sized pieces and well wrapped in tough, moistureproof paper before freezing. Cheap oiled

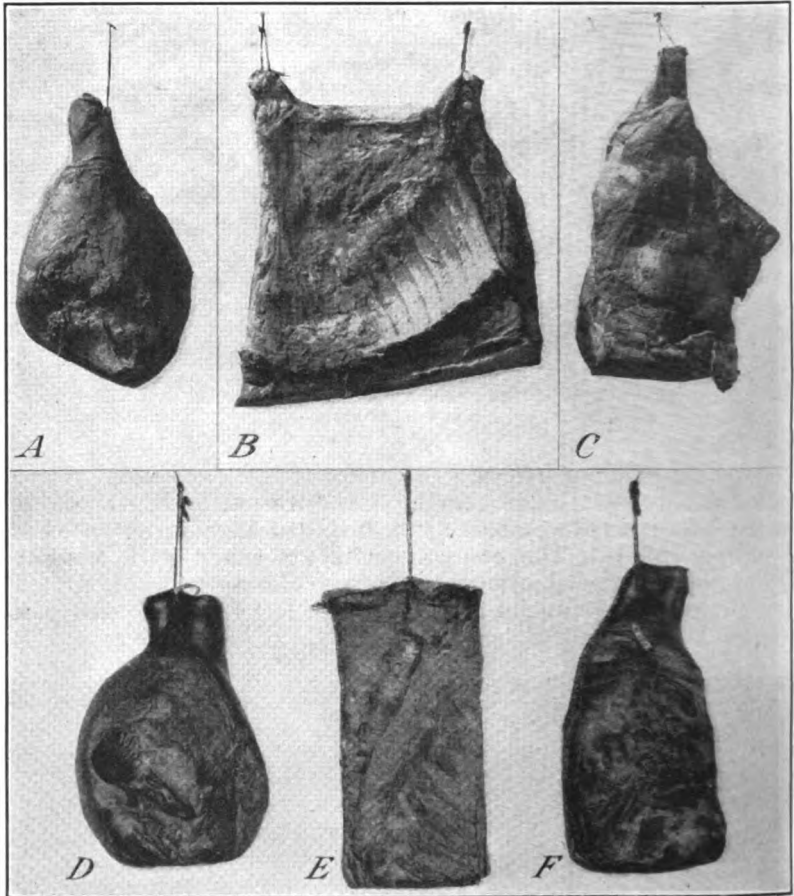


FIGURE 25.—Poorly trimmed ham (A), bacon (B), and shoulder (C). Similar cuts well-trimmed: D, E, and F.

paper or ordinary wrapping paper will not prevent undesirable drying. The wrapped fresh meat should be spread so that it will freeze quickly. When the packages are piled together in the locker it is often several days before the center of the pack reaches the desired temperature. Some trouble has been reported when the meat was piled to freeze.

Long storage periods sometimes result in undesirable drying of the exposed lean surfaces of frozen pork and the development of rancidity in the fat. Protecting the pork by proper wrapping and

by proper temperatures will tend to delay these developments although normally little trouble is encountered during the first month or so of storage. In general, farm families who use a freezer locker try to dress hogs periodically so that they can consume these limited quantities of frozen pork before it has been in storage more than 3 or 4 months.

Frozen pork is cooked with or without being thawed. Thawed or thawing pork is usually moist on the surface, thus affording ideal conditions for the growth of bacteria and mold. If the meat is to be thawed, it is desirable to thaw it in the refrigerator and to cook it promptly.

CURING PORK

Curing is a race between the multiplication of spoilage bacteria in the curing pork and the penetration of the preserving salt. It takes weeks for the salt to reach sufficient concentration to protect the center of hams and shoulders. Low temperatures are the best means known today to prevent the growth of spoilage organisms in meat until the salt has completed the task assigned to it.

In packing houses well-chilled pork cuts are cured at a temperature between 36° and 38° F. This appears to be the safest range of temperatures to use. At the same time much meat is cured on the farm at temperatures above 40° and even up to 50°, although much meat may be lost at these higher levels. The 36°–38° level throughout the curing period is the safest rather than the only one that can be used. This fact should be understood when ice-chilled curing boxes averaging 42°–48° temperatures are used.

Temperature levels are believed to influence flavor as well as soundness. Uniform temperatures normally result in a uniform saltiness and flavor development from microbial and chemical action.

CURING INGREDIENTS

SALT

Salt preserves and dries meat, but in excessive quantities will impair the flavor and make the lean muscles undesirably hard. Insufficient quantities will fail to check the development of putrefactive bacteria. A good grade of clean, common dairy or table salt is desirable.

SUGAR

Sugar is used mainly to lessen the harshness of the straight salt cure and to improve the flavor and texture of the meat. Brown or cane sugar may be used. Select the one that gives the desired flavor.

NITRATES

Saltpeter (nitrate of potash) preserves and dries the meat but is used almost entirely because it effectively fixes the bright-red color of the lean meat. Nitrate of soda (Chile saltpeter) is a little stronger, and 1.7 ounces of nitrate of soda will replace 2 ounces of saltpeter. The exact quantity of saltpeter or of nitrate of soda to be used should be weighed and mixed thoroughly in the curing mixture. It is undesirable and unnecessary to use more of either saltpeter or nitrate of soda than is recommended.

PEPPER

Pepper is sometimes dusted on the cured meat to add flavor.

SUGAR CURE

Most persons prefer the sugar cure to the plain salt cure. It can be applied by either the dry or brine method. The dry method is faster, so it is used almost exclusively in the South for hams and shoulders. Both methods are used for all cuts in colder climates. The brine method will produce a milder bacon than the ordinary dry cure.

BRINE METHOD

The standard curing mixture for each 100 pounds of meat is 8 pounds of salt, 2 pounds of sugar, 2 ounces of saltpeter, and $4\frac{1}{2}$ to 6 gallons of water.

Weigh the meat and put the measured or weighed water (8 pounds=1 gallon) into a crock or clean, well-soaked, odorless, hard-wood barrel. Pour the curing ingredients into the water and stir until they dissolve.

CURING HAMS, SHOULDERS, AND BACON

If a salinometer is available use a little less water to dissolve the salt than is suggested. Then test the strong brine and dilute it to proper strength. The standard curing mixture dissolved in $4\frac{1}{2}$ gallons of water will make a brine that tests about 75° on the salinometer. This is excellent for curing hams and shoulders. When $5\frac{1}{2}$ gallons of water is used the weaker brine, testing 65° , will produce a desirable mild bacon.

If the brine is sterilized by boiling, it should be thoroughly cooled before being used. Under ideal conditions both the brine and meat will be at a temperature of about 38° F. when the pack is put down.

The chilled hams and shoulders are packed away, skin side down, in the crock or barrel. Fit them closely together, but take care not to squeeze them out of shape. Pour in the cold, 75° brine until the pack begins to shift or float a little. This movement permits the brine to come in contact with all parts of the meat. Then add a clean weight just heavy enough to keep the meat below the surface and cover the pack with brine.

Sometimes the shape of the curing vessel or the loose packing of the meat makes the estimated amount of brine insufficient to cover the meat. If it is impossible to pack the meat more closely add enough more brine to cover the pack.

On the fifth, fifteenth, and thirtieth days after being put down, the hams and shoulders should be overhauled; that is, they may be placed in another barrel and re-covered with the same brine, or they and the brine may be removed and then replaced in the same barrel. This overhauling remixes the brine and insures its coming in contact with all parts of each cut.

The bacon strips are usually packed skin side down, each piece being crosswise of the one below it. Jowls or shoulder butts may be used to fill any unoccupied spaces. The milder, 65° brine is frequently used for bacon. Overhauling this meat on the third and tenth days is usually sufficient.

CURING TIME

Hams and shoulders are generally held in brine 4 days per pound; that is, a 15-pound ham will not be removed from cure until the sixtieth day. It is probably better to allow the small 4- to 6-pound picnics 25 to 30 days in cure. Bacon can be cured in $1\frac{1}{2}$ to 2 days per pound.

A thin scum of white mold normally forms on top of the brine. If, however, the mold becomes heavy and hard or if the brine becomes ropy so that it drips from the fingers like sirup, the brine should be changed. Remove the meat, scrub it thoroughly with a brush and warm water, and repack it in a cleaned and scalded barrel. The new brine, made after the original recipe, should be diluted to as nearly the saltiness of the old brine as possible. If the hams and shoulders have been in cure a week, use 70° brine instead of 75° ; if more than 2 weeks, use 65° brine. Maintain the original curing schedule. This process may not save the meat, but it is the only course available.

CURING LOINS, SPARERIBS, AND OTHER CUTS

Often the quantity of loin, spareribs, backbone, and other fresh cuts at butchering time is greater than the family can use promptly and economically. These cuts can be preserved by curing as well as by canning and by freezing.

A mild 55° to 65° brine, which contains about 6 gallons of water, is best for the ribs. They can stand a light smoke after a week in cure but are acceptable without the smoking.

The loin may be given a light smoke after about 3 weeks in a 65° brine or may be used without being smoked.

Owing to the quantity of lean meat exposed, these cuts are likely to become dry and harsh if given a long cure or smoke. It will be more satisfactory to use the brine mainly as a means for storing them a short time. Keep the temperature of this meat as near 38° F. as possible while it is curing.

CURING MEAT IN SUMMER

Hogs may be slaughtered in the summer and the meat preserved if there is some way to chill it and keep it cold during the curing period.

DRY METHOD

For dry-curing hams and shoulders, there are many different recipes that call for varying quantities of salt. Five pounds for each 100 pounds of meat is generally sufficient if one is sure that all the salt will be absorbed by the meat. However, since some salt ordinarily falls off or drains away, 6 to 8 pounds is a safer quantity. In the South, where temperatures are often high, the 8 pounds of salt is probably better. More than this quantity should not be used as it may injure the flavor and make the lean meat too hard.

Meat is likely to spoil, regardless of the quantity of salt applied if the freshly slaughtered carcass and the curing meat are held at too high temperatures.

The following curing mixture is recommended: For each 100 pounds of trimmed pork use 6 to 8 pounds of salt, $1\frac{1}{2}$ to 2 pounds of

sugar, and 2 ounces of saltpeter. This is the well-known 8-2-2 recipe and is the same as that used in making the brine cure.

Mix the ingredients thoroughly in a pan and divide into two equal parts by weight. Use one part for the first rubbing, half of the remainder for overhauling the meat on the third day, and the other half for overhauling on the tenth day. In giving the first rubbing, sprinkle a little of the mixture in the bottom of the barrel. Put each ham and shoulder into the pan of curing mixture and rub it thoroughly. Force some salt into the hock and along the cut face of the butt, taking care not to injure the hand on the butt bone. Cover the face of the cut with the mixture and lay the piece carefully in place. Repeat the process in overhauling. The pieces at the top of the original pack should be at the bottom when the meat is resalted.

The same curing mixture, with the salt reduced to 5 pounds, will dry-cure 100 pounds of bacon. Overhauling on the third day will be sufficient.

In applying the curing mixture care must be taken to put the proper, or proportionate amount on each cut. For example, one-half of the 10 pounds of the 8-2-2 curing mixture makes 5 pounds that are to be used when 100 pounds of meat is first put in cure. Each 15-pound ham should receive 15 percent of that 5 pounds of mixture or three-fourths of a pound, each 20-pound ham 1 pound. Bacon strips are frequently oversalted, owing to their large surface in proportion to weight. With a little practice one can soon gage the approximate amount of mixture required by each piece.

Two days per pound is the standard curing time for the dry method. However, it is usually safer to keep 8- to 10-pound hams in the curing mixture for from 25 to 30 days. Farmers who wish to store this meat for summer use often remove the cuts at full time, string them, and allow them to hang for about 2 weeks before smoking them.

Fat backs and shoulder plates may be cured by either the dry or brine method. They are usually left in cure until used.

Pumping concentrated brine into curing meat, poking salt into ham joints, removing the aitch bone, opening the stifle joints and the shoulder joint, or boning and slicing entire cuts, are all variations of an effort to speed up the penetration of the salt. Where proper temperatures are available and the meat is in good condition these methods are unnecessary. Where temperatures are too high or the meat is not in good, sound condition, these methods may or may not prevent spoilage.

SMITHFIELD-STYLE HAM

A special type of cured ham is prepared in the South Atlantic States, oftentimes from hogs that have been partly fattened on peanuts. These hams, often known as Smithfield-style hams, are cured in a dry mixture for from 5 to 7 days, depending on their weight. They are then overhauled, resalted, and held in cure from 25 to 30 days (1½ days per pound). After the salt cure is completed they are washed in warm water, dried, sprinkled with pepper, and cold-smoked (70°-90° F.) for from 10 to 15 days, after which they are

aged and mellowed by hanging in a dry room for a period as long as 1 year.

PICKLED PIGS' FEET

In the preparation of pickled pigs' feet, special care must be taken to clean them thoroughly. The toes and dew claws should have been removed when the carcass was dressed. The glandular tissue between the toes should be trimmed out and all hair and dirt removed. Unless they are cared for properly, feet begin to spoil about as quickly as any part of the carcass; therefore, after thorough chilling they should be put in cure at once. The clean, chilled feet are usually put in the ham brine for from 15 days to 3 weeks and then cooked or simmered slowly until tender. Cook them slowly enough so that the skin will not part too badly and the feet pull out of shape. The cured, cooked feet are then thoroughly chilled and packed in cold, moderately strong (35-grain) vinegar, to which spices such as bay leaves or allspice may be added. The feet may be used at once or kept in the vinegar for 3 weeks or even longer.

Souse is made by cooking cured or uncured feet in a little water until the meat slips from the bones. The meat and strained soup in which the feet were cooked are then seasoned with vinegar and spice, brought to a boil, put in molds, and allowed to jell. Additional cooked pork trimmings may be added.

SMOKING CURED MEAT

Cured pork is smoked, primarily, to give the meat its familiar color and flavor and to evaporate some of the moisture from it. The small quantities of smoke products deposited on smoked meat also assist in sealing the surface and in delaying the development of rancidity in the fat. Relatively high smokehouse temperatures (110° F. or above) with a light smoke will speed up the drying; lower temperatures (80° to 110° F.) with a dense fog of smoke will intensify the smoky flavor in the meat. If the smoky flavor is not desired and the meat is not smoked, it should be hung up to dry until the dry-cured meat loses about 5 percent of its cured weight and the brine-cured meat loses about 10 percent.

Smoked, cured meat will have a brighter color and a milder flavor if it is freshened in cold water before being smoked. Hams and shoulders are soaked about 2 hours and bacon about 30 minutes. Most farmers do not soak the hams and shoulders that are to be stored for summer use.

All pieces to be smoked should be strung and scrubbed with warm water to remove the excess salt and grease. Hams and shoulders should be strung through the shank. Unless a regular stringing needle is at hand make an opening through the shank with the narrow blade of the boning knife and pull a stout string through with a wire loop (fig. 26). A wooden or wire skewer is usually run through the flank end of the bacon strip and the string inserted just below it (fig. 25, *E*). This keeps the piece square while it is hanging in smoke.

It is usually best to hang the cured, washed meat in the smokehouse overnight to drain and dry. Start the fire in the morning. If the

meat is still dripping when smoking begins the lower pieces will be streaked. Hang the meat so that no two pieces touch.

Cured pork may be smoked at a temperature of 100° to 120° F. The ventilators should be left open, especially at first, to permit the moisture to escape. A heavy fog of smoke is unnecessary. Continue the smoking until the meat has the desired color. Two days' smoking should give it a rich mahogany brown.

Meat that is to be aged or held for summer use is usually smoked more slowly. The temperature is held at 70° to 90° F. and the fires rebuilt intermittently over a period of from 1 to several weeks. This is as much a drying as a smoking process and is believed to assist

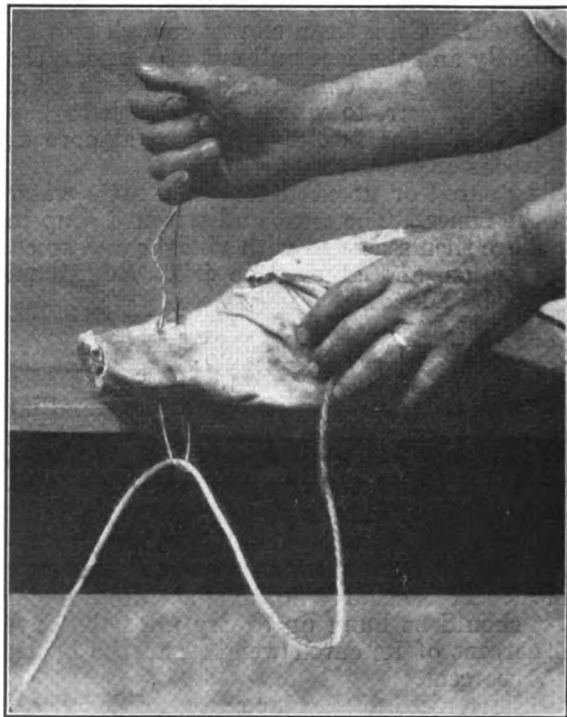


FIGURE 26.—Stringing a cured ham for smoking.

in preserving the meat and in the normal development of the mellow flavor characteristic of smoked pork that has been aged several months.

Smokehouse construction may vary from the barrel type to the elaborate six- or seven-story buildings used by commercial plants, but the general design of all is the same. There is a damper at the bottom to regulate the draft on the fire, enough distance from fire to meat to protect the meat from scorching, and a damper in the roof to permit the escape of evaporated moisture and to control the passage of the smoke past the meat.

A distance of 10 feet between meat and fire is safe. If the distance is only 5 or 6 feet, an inverted tub or metal shield should be placed above the fire to deflect the direct heat. A tight, preferably fireproof, building 6 feet wide, 6 feet long, and 8 feet high is a common type. Almost all cement or building-tile companies will supply plans for smokehouses, giving detailed directions for construction.

Green hickory wood and sawdust are the standard fuels for smoking meat, but almost any hardwood such as oak, apple, maple, or ash will be satisfactory. Where timber is scarce, corncobs may be used. Any resinous wood will blacken the meat and give it an undesirable flavor. If paper or pine shavings are used to kindle the green hardwood, be sure that all have been completely burned or removed from the fire before the smokehouse door is closed.

A fire built after the Indian fashion, with the sticks radiating from the center like the spokes of a wheel, will become lower and cooler as it burns. Building such a fire is a good precaution, for inattention to a hot fire has ruined the meat in many a smokehouse. Green saw-dust may be used to deaden the blaze.

Under the provisions of the Federal Meat Inspection Act the use of liquid smoke, smoked salt, and like preparations intended to be applied to meat as a substitute for smoking them, is prohibited.

TESTING SMOKED MEATS

Sourness in smoked pork can often be detected when the warm meat is removed from the smokehouse, and often a taint will be noticeable a week or two after smoking, but most of the meat that has safely reached this stage may be considered sound. A ham trier may be used to test each piece. This instrument resembles a narrow 10-inch harness awl. A length of stiff wire sharpened at one end may also be used. This trier is run along the bone to the center of the ham from both hock and loin ends. If the trier brings out a sweet odor, the meat is sound. If upon withdrawal the trier carries an unpleasant odor, the piece should be cut open and examined carefully for spoilage. If there is a definite odor of putrefaction, it is best to destroy the entire piece. Shoulders are tried in the shank, at the shoulder point, and under the bladebone.

WRAPPING AND STORING SMOKED MEATS

After the smoked meat has cooled, it is ready to be wrapped and stored. Wrapping protects the meat from insects and partially excludes the light and air that speed the development of rancidity in the fat. Many farmers rub pepper on the meat at this time to add flavor. Ground black pepper, with or without a little red pepper, may be used. The meat is then well covered with parchment paper and put into muslin bags. The paper wrapping should be heavy enough to keep the grease from soaking the bottom of the bag. The tops of the bags should be folded over and tied securely, a loop for hanging the meat being made in the outside tie string. Do not hang wrapped meat by the string that passes through the meat as insects may enter the package along the string. Each sack may be further protected by being painted with yellow wash, and then hung up for future use. In preparing the yellow wash, for 100 pounds of hams or bacon use the following: Three pounds of barium sulphate, 1½ ounces of yellow ocher, 1 ounce of glue (dry), and 6 ounces of flour.

Fill a pail half full of water and mix in the flour, breaking up all lumps thoroughly. Mix the ocher in a quart of water in a separate vessel, add the glue, and pour them into the flour-and-water mixture. Bring this mixture to a boil and add the barium sulphate slowly, stirring constantly. Make the wash the day before it is required. Stir it frequently while using it and apply it with a brush. Lime, clay, flour, or a similar substance mixed with water to a rather thick consistency, may also be used to paint the bags.

The date for killing and curing should be planned if possible so that the smoked meat can be bagged or put in an insectproof place before the flies appear in the spring. Careful watch should be kept for insect infestation throughout the storage period.

If the meat has been properly cured and smoked it should store satisfactorily in a dry, dark, cool, well-ventilated place. Many farmers keep their hams and shoulders a year or longer until they have developed the mellow flavor characteristic of stored smoked pork.

In humid climates mold may develop very rapidly on the meat but usually can be rubbed or trimmed off without serious loss. Meat should be closely watched for evidence of mold penetration into the body of the meat. Once the mold works in between the muscles it injures the flavor of the meat.

The shrinkage of dry-cured hams and shoulders, just after being smoked, will range from about 8 to 15 percent of their fresh weight, and of brine-cured hams and shoulders, from 3 to 8 percent. At the end of 12 months' storage the shrinkage of either may reach 20 to 30 percent.

Bacon is usually more palatable when freshly cured and smoked. It does not store so well as hams and shoulders, and most farmers prefer to use it during the spring and early summer.

RENDERING LARD

Ordinarily the leaf fat, back fat, and fat trimmings are cooked together. The caul and ruffle fats from the internal organs yield a darker product than the other fats. If they have been removed carefully and washed and chilled promptly, they should have an acceptable odor and flavor.

Lard will render more rapidly and completely if the fat is cut into small pieces before being put into the kettle. Many persons prefer to grind it. Start cooking slowly with a small quantity of fat that can be stirred easily. When this fat has begun to melt add the remainder. The kettle should not be very full, or it may boil over. To prevent sticking and scorching, the fat should be stirred frequently and the fire watched during the entire cooking process.

At the beginning of the process, the temperature of rendering lard will be about 212° F. As the water contained in the fat tissues evaporates the temperature will rise slowly until it reaches 240° or 255°, which is as high as it should be allowed to go.

As rendering proceeds, the residual tissues (cracklings) will brown and float. When they are more nearly completely rendered they will gradually sink to the bottom. Care should be taken at this time to prevent small particles of cracklings from adhering to and scorching on the bottom of the kettle. Many persons stop the cooking when the cracklings are still floating. The more nearly complete rendering, however, removes a greater proportion of the moisture, thus producing lard that will be more likely to keep.

It is advisable to allow the rendered lard to settle and cool slightly before emptying the kettle. The liquid lard may be siphoned or dipped carefully into containers. The rest of the lard, containing the cracklings, is usually put through a press, the lard being strained through a screen covered with two or three thicknesses of cheesecloth. If the hot lard can be put into 5- or 10-pound containers and stored immediately at temperatures near or below freezing, it will chill rapidly enough to produce a fine grain.

Leaf fat will yield from 90 to 93 percent of its weight in rendered lard; a combination of leaf fat, back fat, and cutting fat, from

80 to 85 percent; and visceral fat, from 55 to 65 percent. Well-pressed cracklings derived from skinless fat from an average kettle will constitute 4 to 6 percent of the original weight of the fat.

STORING LARD

Air and light may cause a chemical change in stored lard which results in rancidity. For this reason the containers should be filled as nearly to the top as possible, sealed with a tight cover, and stored in a dark, cool place. Once the lard has become rancid, it is impossible to improve it.

If the moisture has been eliminated from the lard by a thorough rendering, no water-souring should develop during storage.

PREPARING SAUSAGE AND RELATED PRODUCTS

Sausage may be made one of the most desirable and appetizing of all pork products. Often the shoulder, bacon strip, and even the loin and hams are made into sausage along with the trimmings. There are many kinds of sausage, for each of which the seasoning may be varied to suit the individual taste. The few recipes included here are offered mainly as a guide. Desirable sausage can be made only from sound, high-quality materials. Care and accuracy in proportioning the ingredients are also essential.

The sausage grinder should be equipped with two combs or plates, having $\frac{1}{2}$ - and $\frac{1}{8}$ -inch holes, respectively. A small hand stuffer will be convenient.

Fresh pork sausage, and headcheese, may be used without being stuffed, but sausages similar to liver sausage and Bologna-style sausage should be stuffed in casings. Bundles or sets of salted casings may be purchased from almost any butcher. Several types of manufactured casings are also on the market. Animal casings should be soaked for several minutes in warm water and then flushed out immediately before being used. Sausage may be stuffed in muslin bags. After being scrubbed and chilled, the stuffed bags are usually dipped in paraffin.

In stuffing, force enough sausage into the stuffer attachment to fill it. Slip as much soaked casing over the attachment as it will hold. If muslin casing is used, pull the closed end of the casing up tightly against the end of the stuffing tube. These precautions prevent the formation of air pockets in the sausage.

The operator supports the casing at the end of the stuffer with the first finger of his left hand while he turns the crank with his right hand. Pressing upward with the left forefinger and raising the stuffed casing above the end of the stuffer will pack the casing more tightly, thereby keeping out air pockets. Animal casings are cut after the proper-sized ring or length has been stuffed and a new length is then begun.

To tie the casings, drive a tenpenny nail into the far corner of the table and fasten to it one end of a stout, soft, white string 3 feet long. Grasp both cut ends of the casing, for example, a ring of liver sausage, in the left hand and tie them together with two half hitches of the string. Tie the first ring near the nail and each

succeeding one a little farther down the string. When the string is full, cut it free and attach a new one.

FRESH SAUSAGE

The fresh trimmings from which pork sausage is made should be about one-third fat and two-thirds lean. If more fat is included, the sausage may be too rich and will have a large cooking loss. Less fat will make the cooked patties rather hard and dry and difficult to brown.

In making a small quantity of sausage to test the recipe, the following measurements may be used:

- 4 pounds trimmings.
- 5 level teaspoons salt.
- 4 level teaspoons ground sage.
- 2 level teaspoons ground pepper.
- $\frac{1}{2}$ level teaspoon ground cloves or
- 1 level teaspoon ground nutmeg (if desired).
- 1 teaspoon sugar.

For 100 pounds of trimmings use the following:

- $1\frac{3}{4}$ pounds salt.
- 2 to 4 ounces ground sage.
- 2 to 4 ounces ground pepper.
- $\frac{1}{2}$ to 1 ounce red pepper (if desired).
- $\frac{1}{2}$ to 1 ounce ground cloves, or
- 1 ounce ground nutmeg (if desired).
- 12 ounces of sugar may also be included if the sausage is to be used reasonably soon.

The seasoning should be well mixed, spread over the trimmings, and the whole quantity ground through the fine plate. Some persons prefer to grind the unseasoned meat through a plate with $\frac{1}{2}$ -inch holes and then mix it with the spices and regrind through a plate with $\frac{1}{8}$ -inch holes.

If the sausage is to be put into casings it should be stuffed immediately after grinding. It should then be soft enough to pack tightly in the casings without the addition of cold water. It may also be fried down or canned.

To make bulk sausage that will slice and fry without crumbling, add a scant half cup of cold water to each 4 pounds of ground seasoned sausage and knead with the hands until the meat becomes very sticky and doughlike. Pack tightly in small molds or pans and allow it to chill before slicing.

SMOKED SAUSAGE

Use pork sausage made with 2 pounds of salt, instead of $1\frac{3}{4}$ pounds, per 100 pounds of trimmings. If it is too stiff to stuff properly, add from 3 to 5 percent of cold water and knead until the mass becomes doughlike. Stuff tightly in casings and allow it to cure for about 24 hours in a cool place. Smoke and dry at a temperature of 70° to 90° F. for a day or two until a dark mahogany color is obtained. This sausage should not be kept until hot weather unless it is canned.

BOLOGNA-STYLE SAUSAGE

Bologna-style sausage consists of ground pork and beef mixed with enough water to give the sausage the desirable fine, tenacious texture. Commercial concerns sometimes grind warm beef from freshly slaughtered cattle with cracked ice because this method gives a still finer grain to the finished product.

One standard recipe for Bologna-style sausage is as follows:

60 pounds beef.
 40 pounds pork trimmings.
 20 pounds cold water.
 2 to 2½ pounds salt.
 1 ounce saltpeter.
 2 to 4 ounces black pepper.
 1 to 1½ ounces coriander.
 1 ounce mace.
 Onions (if desired).

Grind the chilled beef trimmings with salt at the rate of 2 pounds per 100 pounds of beef. Use the coarse grinding plate, and allow the meat to cure in a cool place for about 48 hours. Salt, in the same proportion, is added to the coarsely ground pork the next evening and the pork is allowed to cure overnight. Many persons do not cure the pork.

Regrind the cured beef, using the plate with ⅛-inch holes. Then add the pork and grind the mixture again. If the pork was not cured add the salt (13 ounces for each 40 pounds of pork) before grinding. Add the spices and the water and stir or mix vigorously until the whole mass has become sticky. It often takes 30 minutes to mix this sausage properly.

Stuff the sausage tightly into beef casings or muslin bags and allow it to hang and cure in a cool place until the next morning. Put it in a well-ventilated smokehouse heated to 110° to 120° F. Protect the casings from a direct blaze that might scorch them. The sausage should take on a rich mahogany brown in about 2 hours' smoking.

Put the hot, freshly smoked sausage immediately into water heated to 160° to 175° F., and cook it until it squeaks when the pressure of the thumb and finger on the casings is suddenly released. The usual cooking time for sausage stuffed in beef "rounds" is 15 to 30 minutes; for larger casings 60 to 90 minutes. Plunge the cooked sausage into cold water and chill it. Hang it in a cool place.

COOKED PRODUCTS

Cooking is a convenient means of preparing the edible parts of cuts that are difficult to bone, such as the head, feet, and tail. It is also a means of utilizing miscellaneous pieces of trimmings, liver, heart, tongue, and the soup in which the meat has been cooked.

All meat should be well trimmed and washed before being cooked. The teeth, nasal passages, eyes, and eardrums should be removed. If the lips, snout, and ears have been well cleaned, they may be included. The jowl is usually cut off and cured. It may be added but will often cause the headcheese and scrapple to be too fat.

The feet should be well shaved and cleaned and the glandular tissue between the toes trimmed out.

HEADCHEESE

Headcheese is easily made. Make deep cuts in the jowls or other thick pieces of meat, cover with water, and simmer until the meat is well done and slips easily from the bones. The skin, if used, should be cooked in a net or sack so that it may be removed when so tender that a finger can be pushed through it. The thick ears and snouts will require longer cooking than the other skin. The skin is ground with the plate having $\frac{1}{8}$ -inch holes. The jowls and other pieces are boned after being cooked. These, with the boneless pieces such as the heart, are ground with a plate that has $\frac{1}{2}$ -inch holes. Some persons prefer to cut the tongue and some of the larger pieces of fat into strips instead of grinding them.

The finely ground skin and coarsely ground pieces are then mixed with enough of the soup—the water in which the meat was cooked—to make the mass soft without being sloppy. This mixture is returned to the kettle and brought to a boil. This reheating serves to mix the gelatin thoroughly through the soup so that when the headcheese is poured into shallow pans and chilled it will slice without crumbling.

Seasoning is added at the beginning of the second cooking. Usually it is safe to season to taste though the following quantities of seasoning per 100 pounds of cooked meat, including the added soup, are a satisfactory guide:

- 2 to $2\frac{1}{2}$ pounds salt.
- 3 to 5 ounces black pepper.
- $\frac{1}{4}$ to 1 ounce red pepper (if desired).
- 1 ounce ground cloves (if desired).
- 1 ounce coriander (if desired).
- 2 ounces sweet marjoram (if desired).

If headcheese is stuffed into casings, it should be seasoned and stuffed before the second cooking. The stuffed headcheese should then be replaced in the remaining soup and simmered until it floats. This will require from 10 to 30 minutes. It is then chilled in cold water and stored in a clean, cool place.

Headcheese is usually eaten cold, sometimes with vinegar.

LIVER SAUSAGE

Cook heads, tongues, skins, hearts, and other pieces as for headcheese, but for a shorter period. Remove from the fire when the cuts can be boned. Scald the livers last. If they are deeply cut with a knife they should be sufficiently seared in about 10 minutes. Liver adds a definite flavor to this sausage; 10 to 20 percent of liver, by weight, is usually added to the other cooked products.

Grind all the cooked materials moderately fine and add about one-fifth as much soup by weight, using enough soup to make the mixture soft but not sloppy. Season to taste and mix thoroughly. The following are standard quantities of seasonings for 100 pounds of the mixture:

- 2 to $2\frac{1}{2}$ pounds salt.
- 2 to 4 ounces black pepper.
- 1 to 3 ounces sage (if desired).
- $\frac{1}{4}$ to 1 ounce red pepper (if desired).
- 1 to 2 ounces allspice (if desired).

The seasoned, well-mixed sausage is usually stuffed in beef casings and simmered in water until it floats; usually the time required is 10 to 30 minutes. After being cooked, the sausage is plunged into cold water, chilled for at least 30 minutes, and hung up to drain.

If the meat is cooked too much in the first kettle, the second cooking, after the sausage has been stuffed, will destroy the tight "live" texture of the finished sausage.

SCRAPPLE

Scrapple, an especially favored breakfast dish in many sections, is composed of cooked pork and soup thickened with corn meal, flour, and sometimes shorts.

Cook the heads, hearts, and trimmings as for liver sausage, or until the bones can be removed. Cook the skin, if used, until tender. Grind all the material through the fine plate. Return all the ground material to the soup after it has been strained to remove the bones, and bring it to a boil.

The cereal mixture to be added may vary widely. One consisting of 7 parts corn meal and 3 parts white or buckwheat flour or 7 parts corn meal, 2 parts shorts, and 1 part buckwheat flour, should be acceptable.

Four parts ground cooked meat products, 3 parts soup, and 1 part dry cereal mixture (by weight) will produce a richly flavored, satisfactory scrapple. More meal and soup may be used if desired.

In adding the cereal mixture, moisten it with some of the cooled soup so that it may be added to the hot soup without forming lumps. Boil it for about one-half hour, stirring it frequently or constantly to prevent sticking. Add the seasoning shortly before the cooking is finished and stir it in well.

The following seasonings may be used for 100 pounds of scrapple, including the soup and the dry cereal mixture:

- 2 to 2½ pounds salt.
- 2 to 4 ounces black pepper.
- 2 to 4 ounces sweet marjoram.
- 2 to 4 ounces sage (if desired).
- 1 ounce red pepper (if desired).
- 1 ounce nutmeg (if desired).
- ½ ounce mace (if desired).
- 2 pounds ground onions during second cooking (if desired).

The hot scrapple is poured into small shallow pans and chilled as promptly as possible. If properly made, it can be sliced and fried quickly without much crumbling. The slices may be dipped in egg before they are fried.

PANHAS

The soup remaining after the making of headcheese or liver sausage may be used to make a kind of corn-meal mush called panhas. Strain out all bones, bring the soup to a boil, and add the meal slowly. A safe method of preventing the formation of lumps is to moisten the meal beforehand with a little cooled soup, adding enough of the liquor to make a thick paste.

Three or four parts of soup to one part of meal, by volume, is a good proportion. Season to taste with the seasonings given for head-

cheese. Cook the meal 30 to 45 minutes and pour it into shallow pans to cool. Slice and serve like scrapple.

CANNING PORK ²

Pork may be canned successfully in the home, provided it is processed under steam pressure. The temperatures required for effective sterilization (240° to 250° F., corresponding to 10 and 15 pounds steam pressure) cannot be obtained inside the can or jar except by the use of the steam pressure canner. The water bath, the oven, and the steamer without pressure are inadequate for canning pork and cannot be used safely. If a pressure canner is not available, other methods of preservation should be used.

All pork for canning should be clean and sound. Unless the pork is to be canned at once, chilling the carcass after slaughtering is necessary. Chilling makes little difference in the flavor or tenderness of the canned product. Chilling is recommended, however, as raw meat is easier to handle after chilling, may be held for a few days until it is convenient to can it, and there is less danger of spoilage if canning is unexpectedly delayed.

TYPES OF CONTAINERS

The most desirable utensils for the preparation of meat for canning are preferably enamelware, aluminum, tin, or other stainless metal. Meat should not be allowed to remain in contact with galvanized iron more than about 30 minutes, or it may take up harmful quantities of zinc. Wooden utensils or surfaces require special care in cleaning to free them from bacteria. They should be scrubbed with soapy water to remove all grease and then thoroughly rinsed with boiling water. If used for several days at a time they should be disinfected with a hypochlorite solution (calcium, potassium, or sodium hypochlorite) applied after the scrubbing and scalding.

Plain tin cans and glass jars are used for the home canning of pork.

In canning meat the head space (space at the top of the can) is particularly important. If the liquid does not cover the meat, it will discolor and lose flavor during storage. In packing containers allow the following head space: Glass jars, one-half inch; No. 1 tin cans, one-fourth inch; No. 2 tin cans, five-sixteenths inch; No. 3 tin cans, three-eighths inch.

The sizes of containers most suitable for meat products are No. 2 and No. 2½ tin cans, and pint glass jars. The No. 3 tin cans (quart) and quart glass jars require much heavier processing, and though times are given for them in table 1, their use is not recommended.

²This information concerning the preservation of pork by canning is from Farmers' Bulletin 1762, Home Canning of Fruits, Vegetables, and Meats, prepared by the Bureau of Home Economics, U. S. Department of Agriculture. More detailed directions for the canning of pork may be obtained from the Bureau of Home Economics.

TABLE 1.—*Timetable for processing pork in various containers in the steam pressure canner at 250° F., or 15 pounds pressure*¹

Product	No. 2 can	No. 2½ can	No. 3 can	Pint glass jar	Quart glass jar
	<i>Minutes</i>	<i>Minutes</i>	<i>Minutes</i>	<i>Minutes</i>	<i>Minutes</i>
Fresh pork	85	110	120	85	120
Headcheese	90	-----	-----	90	-----
Liver paste	90	-----	-----	90	-----
Sausage	90	115	-----	90	120

¹ At altitudes over 2,000 feet, add 1 pound of pressure for each additional 2,000 feet. After processing, cool tin cans at once in cold water. Better results are obtained by canning pork in No. 2 and No. 2½ cans or pint glass jars rather than in No. 3 cans or quart glass jars.

When glass jars are used, pork should be precooked in the oven or in water before being packed in the container. When tin cans are used, the meat may be precooked in either of these ways and packed hot, or it may be packed raw and the cans exhausted before being sealed. The latter method gives a little better flavored product, and the liquid is all meat juice; but it takes more time and stove space. Frying is not recommended as a method of precooking meat for canning, because it makes the meat hard and dry and may give it a disagreeable flavor.

PARTS BEST SUITED TO CANNING

In the preparation of pork for canning it is especially important to trim off practically all the fat. When much fat is canned with the lean meat it causes correspondingly greater shrinkage during processing as the fat melts. The fat may also interfere with the destruction of bacteria and make the canned product more likely to spoil. Cuts of pork that contain rather large proportions of fat are more economically preserved by curing because of the heavy trimming and shrinkage they undergo in canning. The parts of pork usually canned are: Loin, meat from spareribs; head, tongue, and heart in headcheese; loin and lean trimmings in sausage; and liver in liver paste. Hams and shoulders may be canned, but they are generally cured.

Salt is added as follows: One-half teaspoon to a pint jar, three-fourths teaspoon to a No. 2 or No. 2½ can, and 1 teaspoon to a quart jar or No. 3 can. When tin cans are used, place the salt in the cans before packing them with meat.

FRESH PORK

Remove excess fat from the meat to be canned and precook the meat by any of the methods described on page 36. Pack hot and process as directed in table 1.

HEADCHEESE

Prepare headcheese as directed on page 32. No sage should be used as it may become bitter after canning. Pack the headcheese hot into containers and process as directed in table 1. It is better to use tin cans so that when the can is opened the product may be removed in a single piece.

PORK LIVER PASTE

Pork liver may be canned as liver paste, which is made as follows:

3 pounds liver.	1 medium-sized onion, chopped.
1½ pounds fat fresh pork.	3 eggs.
2 tablespoons salt.	6 tablespoons fine dry bread crumbs.
1 teaspoon white pepper.	½ cup water.
½ teaspoon ground cloves.	

Wash the liver thoroughly and remove veins and tough membranes. Grind the raw liver and pork twice through a plate with ⅛-inch holes, to make it very smooth. Add the seasonings. Beat the eggs well and combine with the bread crumbs and water. Stir all ingredients together until well-mixed. Pack into No. 2 cans, leaving 1 inch of head space, and exhaust until the paste is heated through to the center of the cans. This requires about 40 to 50 minutes. Remove some of the paste or add a little hot water if necessary so that the cans have the proper head space before sealing. Process as directed in table 1.

PORK SAUSAGE

Prepare the sausage as directed on page 30, but omit the sage because it gives the sausage a bitter flavor after processing. See that the seasonings and meat are well-mixed together.

If using tin cans, pack the raw sausage closely into the No. 2 size and exhaust the cans until the sausage is steaming hot. This requires 40 to 50 minutes. Process as directed in table 1. Before opening a can, heat it for a few minutes in boiling water, then slip the contents of the can out in one piece, slice into rounds, and reheat in gravy or in an oven.

If glass jars are used, mold the sausage into cakes and precook in a moderate oven (350° F.) for 10 to 15 minutes, or until the cakes are slightly browned and the color of raw meat has almost disappeared. Pack into the jars and cover with the drippings or with hot water. Process as directed in table 1.

PRECOOKING IN WATER

Cut the meat into uniform pieces weighing about 1 pound and place them in boiling water. Partly cover the kettle and simmer for 12 to 20 minutes, until the color of the raw meat has almost disappeared from the center of the pieces. At this stage the meat has lost about one-third of its original weight, as some of the juice has cooked out. Cut the meat into smaller pieces immediately, pack it into the containers, and press it down closely with a wooden mallet or pestle. Cover with the broth, leaving proper head space, and process immediately. This method, commonly referred to as parboiling, is the quickest way to precook a large quantity of meat.

PRECOOKING IN TIN CANS

Precooking should never be attempted with glass jars because of danger of breakage. Pack two or more pieces of meat into each can, and place the filled but open cans in a bath of boiling water that comes to within 1½ to 2 inches of the top of the can. Cover the bath to hold in steam and heat, being careful that water from the bath

does not bubble into the cans. Continue heating until the meat is steaming hot, or 170° F., at the center of the cans, and has practically lost its raw color. If no thermometer is available, turn out the meat from a few of the cans to be sure it is heated through. The time required is about 40 to 50 minutes for No. 2 cans. Press the meat down and be sure it is covered with broth and that there is proper head space in the cans. Seal at once and process immediately.

PRECOOKING IN THE OVEN

Cut the meat into uniform pieces weighing about 1 pound each, and cook in a moderate oven (350° F.) until the raw color of the meat almost disappears at the center. This requires about 30 to 40 minutes. Cut the meat so that there are two or more pieces to each container, to facilitate heat penetration, pack at once closely, cover with pan drippings or with boiling water, leaving proper head space, and process immediately.

REGULATIONS FOR SHIPPING MEAT OR MEAT FOOD PRODUCTS

Farmers who ship their meats must comply with official State and Federal regulations. Below is shown a sample shipper's certificate such as must be used in interstate shipments of uninspected meat or meat food products which are from animals slaughtered by the farmer on the farm. Blank certificates should follow this sample. In size the certificate should be 5½ by 8 inches.

Shipper's Certificate

Date_____ 19____

Name of carrier_____

Shipper_____

Point of shipment_____

Consignee_____

Destination_____

I hereby certify that the following-described uninspected meat or meat food products are from animals slaughtered by a farmer on the farm, and are offered for transportation in interstate or foreign commerce as exempted from inspection according to the act of Congress of June 30, 1906, and at this date they are sound, healthful, wholesome, and fit for human food, and contain no preservative or coloring matter or other substance prohibited by the regulations of the Secretary of Agriculture governing meat inspection.

Amount and weight.

Kind of product_____

(Signature of shipper)

(Address of shipper)

Two copies of this form are to be presented to the common carrier with each shipment.

COOK PORK THOROUGHLY

Man may become infected with a very serious disease called trichinosis through the eating of raw pork. This disease is caused by parasites called trichinae, which are too small to be seen by the naked eye but may be present in the lean meat of hogs. The danger of trichinosis may be entirely avoided by cooking pork thoroughly.

Trichinosis may be contracted from tasting sausage during its preparation to determine when seasoning is satisfactory, from hastily cooked hamburgers that contain some pork, from imperfectly cooked fresh pork, and sausage, smoked hams, bacon, and shoulders, and from improperly prepared ready-to-eat products such as Bologna-style sausage, boneless loins, capocollo, coppa, dry or summer sausage, and Italian-style ham. When these latter products are eaten without further cooking in the home, one must be sure that they have been made in a plant where competent official inspection has insured a treatment of the pork muscle that will destroy possible live trichinae.

COOK PORK THOROUGHLY

A 1.9: 1187

FARMERS' BULLETIN 1187
UNITED STATES DEPARTMENT OF AGRICULTURE

COTTON DISEASES *and their* CONTROL



Disease.	Control measures.
Wilt.....	Use wilt-resistant varieties. Rotate to reduce root-knot.
Root-knot.....	Rotate with immune crops.
Anthracnose.....	Select disease-free seed of resistant varieties. Rotate crops.
Bacterial blight.....	Select disease-free seed. Rotate crops.
Shedding of bolls.....	Conserve soil moisture— by increasing the humus supply. by late shallow cultivation.
Rust.....	Add humus to the soil. Use potash fertilizers. Drain wet land.
Texas root-rot.....	Plow deeply in the fall. Rotate crops.

Contribution from the Bureau of Plant Industry

WM. A. TAYLOR, Chief

Washington, D. C.

March, 1921

**Show this bulletin to a neighbor. Additional copies may be
obtained free from the Division of Publications, United States
Department of Agriculture.**

COTTON DISEASES AND THEIR CONTROL.

W. W. GILBERT,

Pathologist, Office of Cotton, Truck, and Forage Crop Disease Investigations.

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IMPORTANCE OF COTTON DISEASES.

Cotton is the most important crop in the Southern States and is second only to corn in farm value for the entire country. Several important diseases attack the crop and reduce the yield materially. In some sections certain diseases are so prevalent and severe that profitable cotton crops can not be grown on infested fields by the methods usually employed, but by the adoption of the control measures described in this bulletin good crops can be produced.

The principal cotton diseases which cause damage in the Southern States are described and illustrated in the following pages and the best-known methods of controlling them are described.

WILT.

The disease which causes the largest losses to the cotton crop in the United States is commonly known as wilt, or black-root. The most noticeable symptom is the wilting and death of affected plants. The dead roots of diseased plants turn black, and from this fact comes the common name "black-root."

This disease is widely distributed throughout the sandy soils of the cotton belt from Virginia to Texas, and is spreading year by year to new localities. It is present every year, though in some seasons the losses are heavier than in others. In severe cases the yield is reduced as much as 75 to 90 per cent. The average annual

loss is extremely difficult to estimate, but, judging from the data gathered over a period of 20 years, it no doubt totals millions of dollars.

HOW TO RECOGNIZE WILT.

Cotton wilt may be suspected when plants wilt and die without any apparent reason. If the stem of a freshly wilted plant is cut across near the ground and found to be black or brown inside (fig. 1, A), this is strong evidence of the disease. Plants affected by wilt early in the season are considerably stunted as compared with healthy plants. Frequently the main stem of such a plant remains

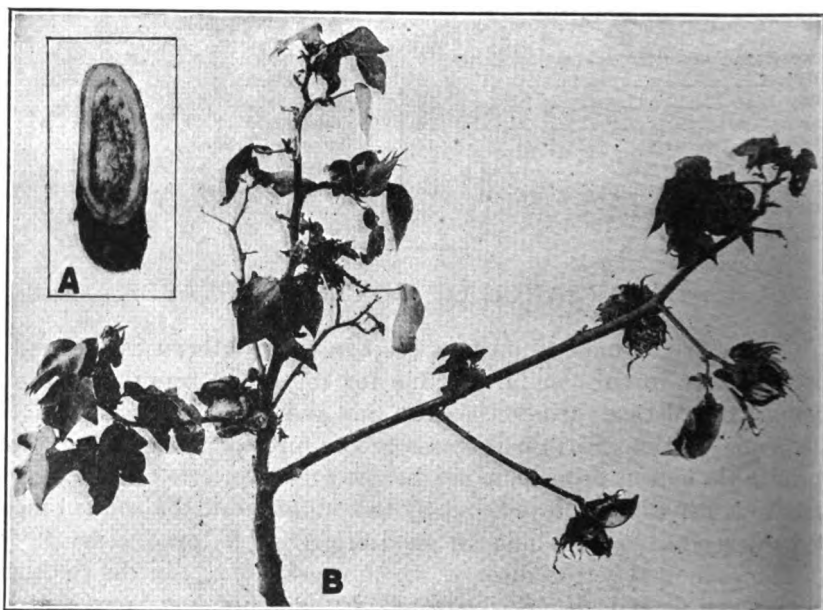


FIG. 1.—Wilted cotton stalk cut across to show the blackening of the inside (A); cotton plant showing the main stalk stunted by wilt and one lower branch normally developed, only one side being infected (B).

short, while one or more of the lower branches grow normally. (Fig. 1, B.) The disease usually occurs first in irregular spots in the field (fig. 2), which increase in size from year to year. Wilt begins to kill plants early, and all through the season affected stalks die.

Wilt must be distinguished from another disease which occurs in parts of Texas and adjoining States and is known as Texas root-rot. (See description on pp. 27-28.)

HOW TO CONTROL WILT.

The planting of wilt-resistant varieties of cotton, combined with the use of proper crop rotations, is the only effective method now

known of controlling wilt. The fact can not be too strongly emphasized that the presence of root-knot (described on p. 10) in many sandy soils throughout the cotton belt makes the wilt more severe. It is therefore absolutely essential that lands infested with root-knot

be planted in root-knot resistant crops for one or more years before wilt-resistant cotton is grown (see p. 11). The use of such a rotation will reduce the root-knot and make more certain a crop from a wilt-resistant variety of cotton.

**USE WILT-RESISTANT
VARIETIES OF COTTON.
ROTATE TO REDUCE
ROOT-KNOT.**

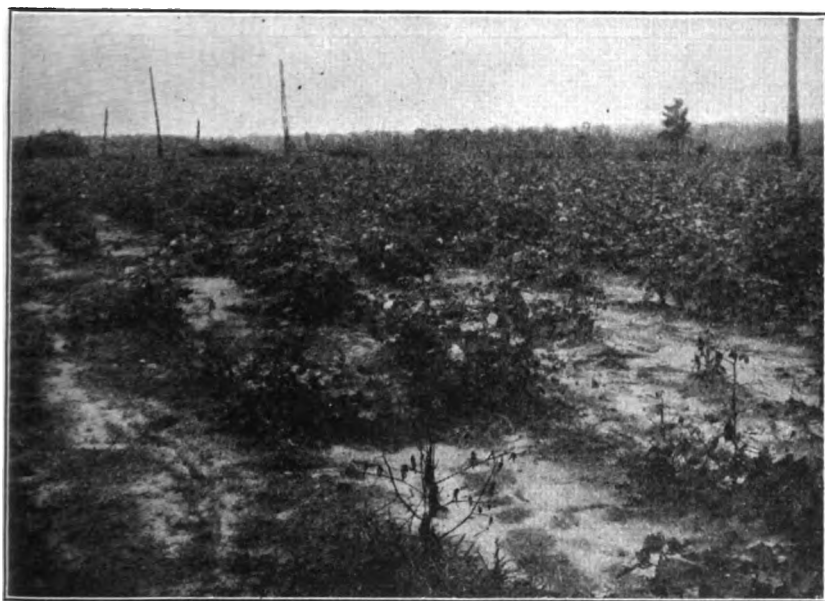


FIG. 2.—Irregular area in cotton field, showing many plants killed and others stunted by wilt. Lamar, S. C.

RESISTANT VARIETIES ORIGINATED BY BREEDING.

Several wilt-resistant varieties of cotton have been bred by the United States Department of Agriculture, by State institutions, and by private individuals, and many thousands of acres of these varieties have been profitably grown on wilt-infested land for 15 or more years. The impression gained by some farmers that wilt-resistant varieties are much less productive than the varieties commonly grown is not warranted by the facts. Yields of a bale or more to the acre are frequently reported, and in addition the best yielding strains are very uniform and almost free from anthracnose.

Most of the commonly grown varieties of cotton are too susceptible to wilt to be profitable on badly diseased land. (Fig. 3.) In general, the large-bolled varieties are more susceptible to the disease than the small-bolled types. Experiments carried on by the Bureau of Plant Industry for the past 20 years have shown conclusively that wilt can be practically controlled in no other way than by the use of varieties specially bred for wilt resistance. (Fig. 4.)

The first wilt-resistant variety, Dillon, was bred by the Bureau of Plant Industry from the old Jackson Limbless. It was productive and highly resistant to wilt and was quite widely grown before other more desirable types were available. The fact that it was a cluster cotton, and therefore rather hard to pick, made it undesirable to many farmers. It has now been largely replaced by the Dixie,

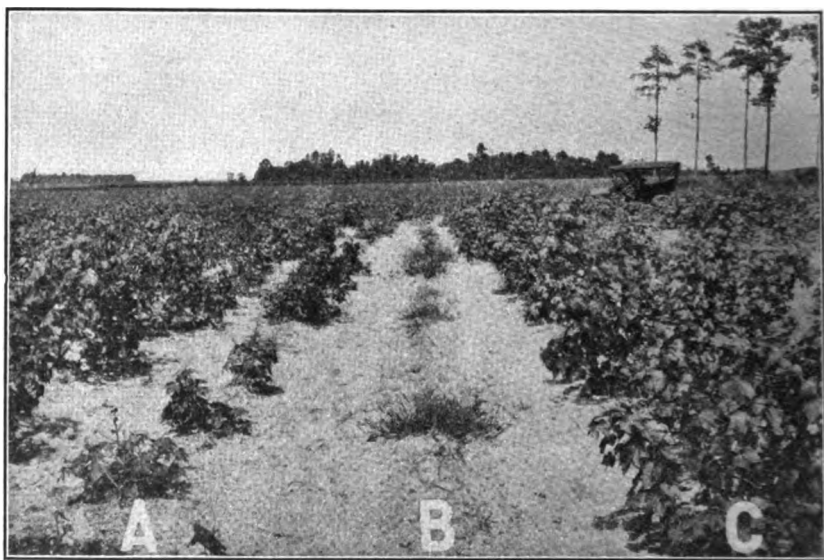


FIG. 3.—Cotton variety test on wilt land, showing great differences in resistance. A and C, hybrid cottons, A being very subject to wilt, while C is highly resistant to wilt; B, Half and Half, nearly all killed by wilt while young. Americus, Ga.

which was the second resistant variety developed by the Bureau of Plant Industry. This variety is of the Peterkin type, with long, fruiting branches. (Fig. 5.) It has oblong, medium-sized bolls, is easy to pick, and is now more widely grown than any other wilt-resistant variety. The Dixie is productive, medium early, has a staple seven-eighths to 1 inch long, and small seeds with brownish-white fuzz. It yields 36 to 38 per cent of lint.

During the past few years other wilt-resistant varieties of cotton which are earlier than Dixie have been bred by the United States Department of Agriculture and are especially adapted for use in sections where the boll weevil is present. The most promising of

these is known by the name of Dixie-Triumph. Its principal advantages are larger bolls, larger yield, and earlier maturity than the Dixie. Another variety of considerable promise is the Dixie-Cook, which is very similar to the Dixie-Triumph and quite as productive on infested land.

Several promising wilt-resistant varieties have also been developed by Mr. A. C. Lewis, of the Georgia State Board of Entomology, and are being grown to a considerable extent in Georgia. Information regarding these varieties can be obtained by writing to Mr. Lewis at Atlanta, Ga. Resistant strains, some of which have considerable merit, have also been developed by a few individual farmers.

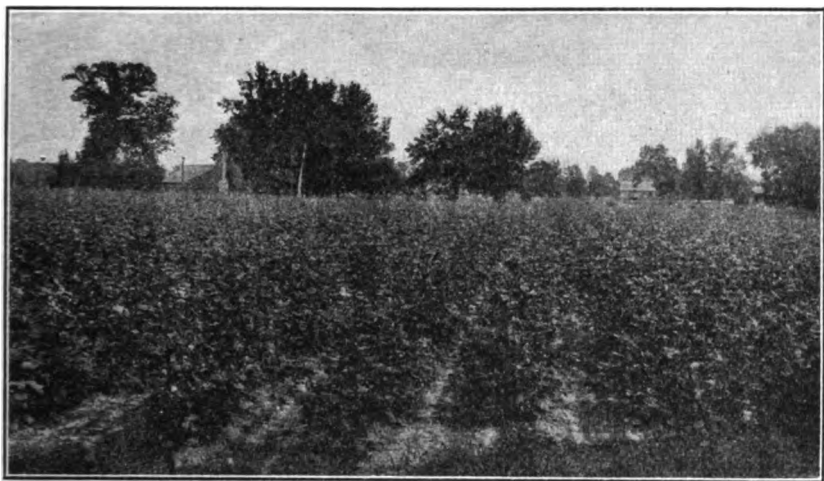


FIG. 4.—Wilt-resistant Dillon cotton growing on soil badly infested with wilt at Lamar, S. C.

HOW TO OBTAIN WILT-RESISTANT SEED.

Wilt-resistant varieties are produced only by careful selection and breeding over a period of years. It will not pay the average farmer to try to develop resistant strains for his own use, as much time and very careful attention are required to perfect them. The best way to secure wilt-resistant seed is to purchase it from a reliable breeder or grower and increase the strain by planting on wilt-infested land, using special care to save planting seed only from plants which do not wilt or show any signs of the disease. The growing of wilt-resistant cotton for seed for more than one year on land not infested with cotton wilt is to be discouraged, since this practice allows the nonresistant plants to increase without there being any way of distinguishing them, while if grown on wilt land they would either die from the disease or be discarded when selections were made.

It is furthermore necessary to practice careful selection and handling in order to maintain the wilt-resistant quality in the cotton, since otherwise it is gradually lost through natural crossing in the field, mixture of seed at the gins, and in other ways. Unless a farmer is prepared to give special attention to the selection of his seed every year in order to maintain its wilt resistance, it is advisable for him to procure from a breeder or grower a new supply of highly resistant seed every two or three years. This is especially true where seed is saved from fields free from or not thoroughly infested with wilt. The reputation of the Dixie has suffered in some cases by farmers



FIG. 5.—Typical plant of Dixie wilt-resistant cotton.

selling and planting as Dixie seed secured several years previously from breeders which had not been properly selected to maintain its wilt resistance. The fact can not be too strongly emphasized that constant and careful selection must be practiced in order to maintain the wilt resistance of Dixie or any other variety of cotton.

The seed stocks of Dixie, Dixie-Triumph, and Dixie-Cook are being grown and improved by farmers in several Southern States under the supervision of

the United States Department of Agriculture, and lists of growers of the best strains, from whom seed can be purchased at reasonable prices, can be secured through the county demonstration agents.

WILT CAUSED BY A FUNGUS.

The wilt disease of cotton is caused by a fungus (*Fusarium vasinfectum*) which enters the roots of the plants from the soil. It grows in the water-carrying vessels of the plants, plugging them and thus shutting off the water supply and causing the plants finally to wilt and die.

Wilt occurs most generally and severely on sandy land. Its occurrence on clay soil is unusual, though several such cases have been reported from South Carolina and Georgia. Wet seasons are more favorable to the disease than dry, and hence the losses are more severe then. Wilt may be spread from field to field by animals, tools, men,

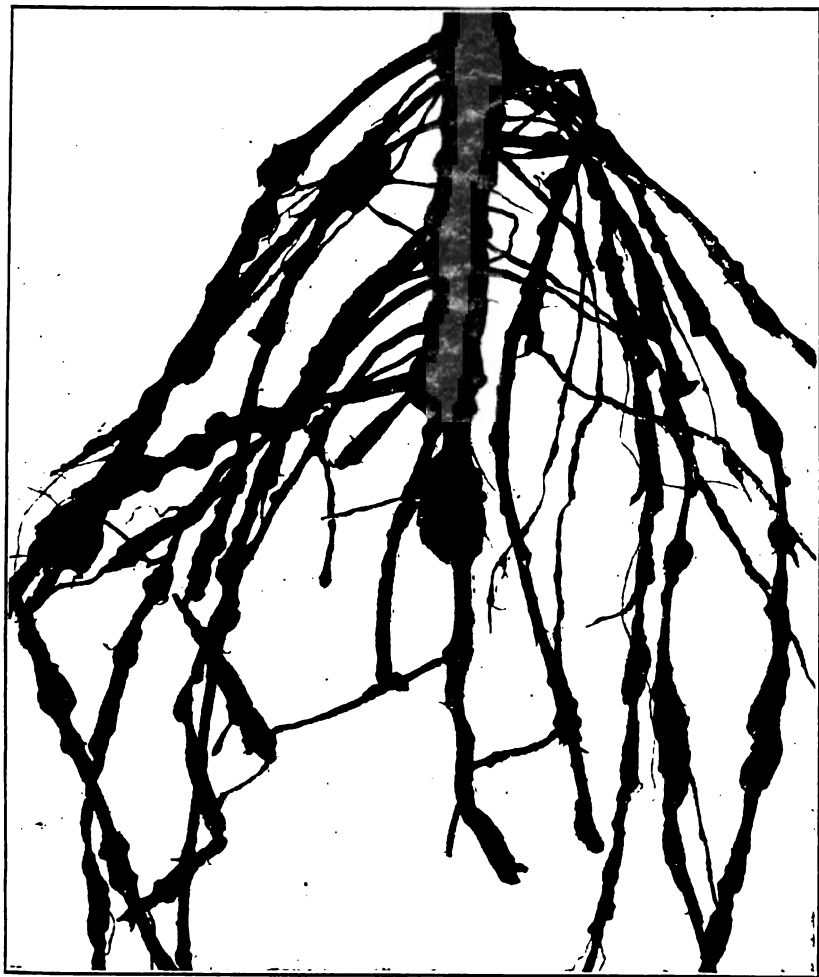


FIG. 6.—Root system of a cotton plant severely attacked by root-knot.

wind, drainage water, or any other agencies which carry the fungous spores. So far as is known, the disease is not carried in or on the seed. Experiments were carried on for four years in which seed was saved from badly wilted plants and planted the following season on sandy land where the disease had never been known, and yet no wilt occurred.

ROOT-KNOT.

Root-knot is next in importance to wilt from the standpoint of money loss to the cotton crop. This disease is more widespread in its occurrence than wilt, though it is found chiefly on the same types and areas of sandy soils. With the exception of the crops mentioned later in the list of root-knot resistant strains or varieties, all other farm crops are more or less subject to root-knot attack and are therefore to be avoided in rotations for infested fields.

APPEARANCE OF SICK PLANTS.

Cotton plants severely attacked by root-knot alone are distinctly stunted, but are not noticeably deformed above ground, as is often the case with plants having wilt. Where the disease is mild the dwarfing may not be noted. Both leaves and stems may have a pale yellowish green color, though this is not always very marked, since all the plants are usually affected alike, and no healthy plants are present for comparison. During dry weather diseased plants may wilt in the middle of the day.

The roots of diseased plants are covered with galls from the size of a pinhead to half an inch or more in diameter, as shown in figure 6. They may occur on the fine feeding rootlets as well as on the large taproot, and are scattered or very close together, depending on the severity of the disease. Young galls are almost white, but when old they turn brown and decay. They are very irregular in shape, and are enlargements of the roots themselves. These galls cut off the food and water supply of the plants and are the direct cause of stunting, while the death of parts of the roots gives entrance to other enemies which cause further damage.

CONTROL ROOT-KNOT BY CROP ROTATION.

Cotton root-knot can be controlled by using crop rotations in which root-knot immune crops are planted on diseased fields and susceptible crops are avoided. On badly diseased fields a rotation of

**ROTATE WITH GRAINS, CORN,
AND ROOT-KNOT RESISTANT
LEGUMES.
AVOID SUSCEPTIBLE CROPS.**

two or three years is advised, and even then not more than one susceptible crop should be grown before planting again with resistant crops.

On less-diseased fields a one-year rotation, including a root-knot resistant summer legume and two crops of winter grain may be sufficient.

In order that safe rotations may be intelligently planned it is necessary to know what crops and plants are immune or susceptible to root-knot. A list is therefore given below.

Crops largely or entirely immune to root-knot.

Barley.	Grass, crab.
Bean, soy (Laredo variety only).	Grasses (nearly all).
Bean, velvet.	Kafir.
Beggarweed, Florida.	Millets (nearly all).
Chufas.	Milo.
Corn.	Oats, winter.
Cowpea, Brabham.	Peanut.
Cowpea, Iron.	Rye.
Cowpea, Monetta.	Sorghum.
Cowpea, Victor.	Wheat.
Grass, Bermuda.	

Crops not very severely attacked by root-knot.

Alfalfa.	Cotton.
Asparagus.	Pea, garden.
Bean, snap.	Potato, sweet.
Cabbage.	Radish.
Cane, sugar.	Spinach.
Clover, sweet.	Strawberry.
Collard.	Vetch, common.

Crops most severely attacked by root-knot.

Bean, Lima.	Eggplant.
Bean, soy (all varieties except Laredo).	Fig.
Beet.	Lettuce.
Cantaloupe.	Okra.
Carrot.	Peach.
Celery.	Potato.
Clover, bur.	Salsify.
Cowpea (all varieties except Iron, Brabham, Monetta, and Victor).	Squash.
Cucumber.	Tobacco.
	Tomato.
	Watermelon.

Weeds attacked by root-knot.

Balloon vine.	Papaya, or melon pawpaw.
Clover, Mexican.	Mayweed.
Fennel, sweet.	Purslane.
Maypop, or passion flower.	

It is not possible to suggest a crop rotation which will fit the particular needs of every farmer. Each must work out the combination of resistant and susceptible crops which will be best adapted to his location and type of farming. Every root-knot rotation should include one or more of the legumes and some of the grain crops, all

of which are highly resistant to root-knot. For the northern Cotton States the root-knot resistant varieties of cowpeas are the most important legumes, though both early and late varieties of velvet beans can be advantageously planted. They are immune to root-knot attack. In the more southern Cotton States velvet beans stand first among root-knot resistant legumes, and their use has greatly increased during the past few years, since their merit has become better known. The root-knot resistant cowpeas and soy beans can also be used where desirable. The planting of susceptible crops on badly diseased fields will almost invariably result in large losses.

A typical two-year rotation which may be varied to suit local conditions is given herewith. Sow winter oats in the fall on the root-knot infested field. Plow them under in the spring and plant • corn with Iron cowpeas between the rows; sow again to a winter grain crop and cut it for hay or grain in the spring; follow with Iron cowpeas and cut them for hay or seed; and plant a third winter grain crop and plow it under in time to plant wilt-resistant cotton the following spring. Any of the other immune crops listed above may be used in the rotation if desired.

HEAVY LOSSES DUE TO ROOT-KNOT.

Root-knot undoubtedly causes greater losses to farm crops than wilt, because of the fact that it attacks a large number of crops, while wilt affects cotton only (see p. 11). It occurs, like wilt, on the sandy Coastal Plain from Virginia to Texas, but it is probably more general and widespread. It also occurs in the Southwestern States, especially in southern California.

While it is most common and causes greater losses in sandy soils, it is known to occur also in some clay soils and especially in soils heavily fertilized with stable manure. The losses in some cases may run as high as 80 per cent. The average losses from root-knot for all sandy lands in a single county in South Carolina were estimated in 1917 at 4.4 per cent, based on a careful survey of over 20,000 acres in seven townships. For the State of Georgia in 1917 the cotton root-knot loss was estimated at 4.1 per cent of the crop. The average annual loss from root-knot for the entire cotton belt is estimated at approximately 200,000 bales of cotton and 100,000 tons of seed, worth about \$16,480,000 at present prices. (December 2, 1920, with cotton at 14.38 cents per pound and seed at \$21 per ton.)

It is essential that every cotton farmer realize that the damage caused by root-knot is not confined to the direct injury to the cotton plant by the nematodes. In addition, root-knot diseased plants are much more subject to wilt, and the two diseases occur very commonly together. For this reason cotton wilt is much worse following

root-knot susceptible cowpeas which have caused an increase of the eelworms in the soil. (Fig. 7.) Furthermore, the loss from root-knot is increased (1) by the greater cost of cultivation of infested land due to the growth of weeds where the cotton has died, (2) by the lowering of the market value of such land, and also (3) by the fact that badly diseased land must often be used for crops less profitable than cotton.

ROOT-KNOT CAUSED BY EELWORMS.

Root-knot of cotton and other crops is caused by tiny eelworms, or nematodes.¹ They bore into the roots from the soil and irritate them, causing the plant to form galls. If one of these galls is broken open, several pearly white rounded bodies about the size of a small pin-

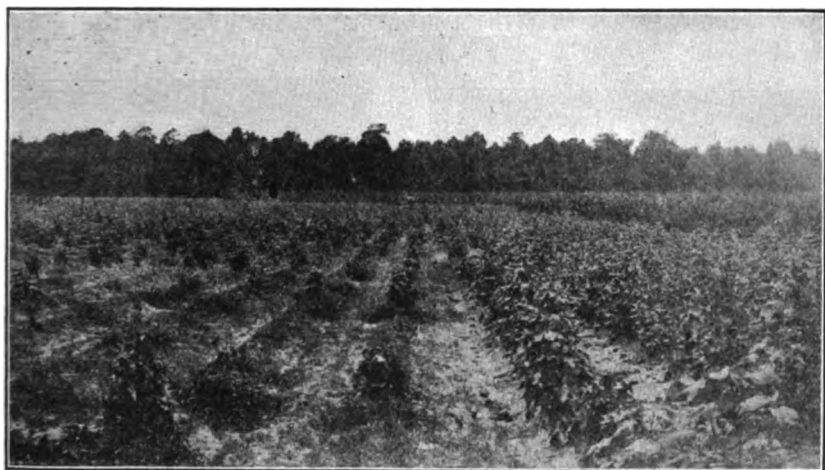


FIG. 7.—Root-knot susceptible cowpeas make wilt worse. Cotton on left after Unknown cowpeas (susceptible); on right after Iron cowpeas (resistant).

head may often be seen with the naked eye. (Fig. 8, A.) These are the female eelworms full of eggs. The male worms are more elongated in shape, but too small to be readily seen without a lens. (Fig. 8, B.)

Root-knot is easily spread from one field to another by any means which will carry some of the infested soil or plant roots. Drainage water, cultivation, tools, and animals are all important agents in spreading the disease. Young nursery stock, young asparagus, cabbage, tomato, or other plants grown in diseased soil may carry the nematodes, as well as infested Irish or sweet potatoes used for seed purposes.

Further detailed information on root-knot and its control will be found in Farmers' Bulletin 648, entitled, "The Control of Root-

¹ *Heterodera radicicola*.

Knot," which will be sent free of charge upon application to the Secretary of Agriculture.

ANTHRACNOSE.

Cotton anthracnose is even more widespread than wilt, since it is known to occur in most of the cotton-growing sections of this country. It annually causes losses which range from slight to as high as 80 or 90 per cent of the crop, with an average estimated at from 1 to 3 per cent. The attacks of the disease vary with seasonal conditions and in general are worse in wet seasons.

DESCRIPTION OF THE DISEASE.

Anthracnose is commonly known to the farmer as boll-rot, or boll-spot, from the fact that the most conspicuous effect of the disease

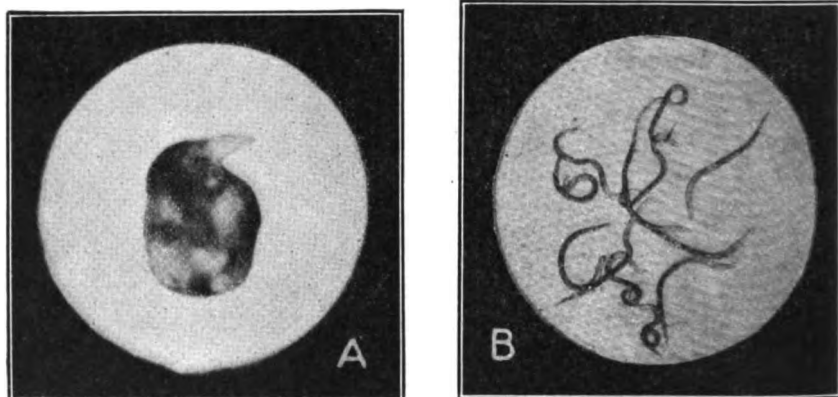


FIG. 8.—Adult female nematode full of eggs (A) ; young male and female nematodes (B).
(Both illustrations greatly enlarged.)

is the rotting of the bolls, which occurs in the latter part of the season. The largest amount of damage is also caused by boll-rot.

On the bolls the disease first appears as small round water-soaked spots (fig. 9, A), which later may enlarge to include most or all of the boll, become black and finally have reddish borders and pink centers (fig. 9, B). The lint from such bolls is usually stained pink, or in the worst cases may be entirely rotten and worthless. Other rots often attack diseased bolls and complete the decay. Diseased bolls often fail to open because the locks have become stuck together.

Another boll-rot, which must be distinguished from anthracnose, is caused by the bacterial blight. In this the spots are at first water-soaked, later becoming black and shrunken, but they do not have the pink centers characteristic of anthracnose. The bacterial disease

also frequently attacks the stem of the boll and causes the entire boll to dry up, often before it is ripe. For a full description, see page 17.

Anthraxnose also attacks the seedlings, killing the young sprouts even before they come through the ground. It often causes damping-off of the little plants or kills parts of the seed leaves during cool, wet weather, which is unfavorable for the growth of cotton (fig. 10). This damping-off is similar to that caused by the "sore-shin" fungus, *Rhizoctonia* (see p. 25), but the wilting is more sudden and the water-soaked appearance is more pronounced in the case of anthracnose attack.

The cotton stems are sometimes attacked by anthracnose, but this more commonly follows the bacterial black-arm (see p. 17).

Anthraxnose lives over winter on diseased bolls or stems left in the field and on the seed from diseased plants.

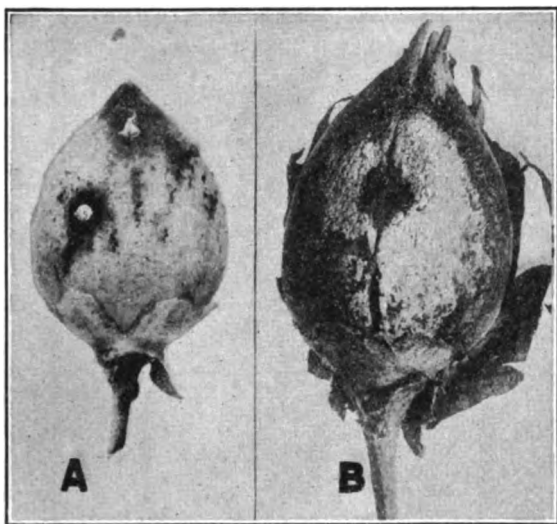


FIG. 9.—Cotton anthracnose on bolls: A, Early stage, small spot with water-soaked appearance and pinkish center; B, entire boll rotted by the fungus.

METHODS FOR CONTROLLING ANTHRACNOSE.

It has been found that the losses from anthracnose can be largely reduced by giving careful attention to seed selection and crop rotation. Seed for planting should be secured only from fields free from

**SELECT DISEASE-FREE SEED
FOR PLANTING.
ROTATE CROPS.**

the disease or be selected from healthy plants at some distance from any which have diseased bolls.

If seed of this kind

can not be obtained, 3-year-old seed from slightly diseased fields may be used, since the disease dies out in the seed in that time. Other methods have been worked out for freeing seed from the disease which are useful for small lots of select seed, but are too

expensive or otherwise not applicable to general use. Among these are seed treatment by sulphuric acid and mercuric chlorid (see p. 19).

Another method of reducing anthracnose losses is to plant varieties which are least troubled by this disease. The Toole, Dixie, Dixie-Triumph, King, Dillon, Cleveland, and Russell cottons are in general fairly free from anthracnose, while varieties like the Cook, Brown, Blue Ribbon, Half and Half, and Columbia are usually quite subject to injury.

It will not pay to continue growing a variety which is known to be particularly susceptible to damage and loss by this disease.

Since anthracnose may live over winter in the soil of diseased fields, it is important that crops be rotated, so that cotton will not be planted on land which grew a diseased crop the previous year. A 2-year rotation will give greater security against the overwintering of the disease in the soil.

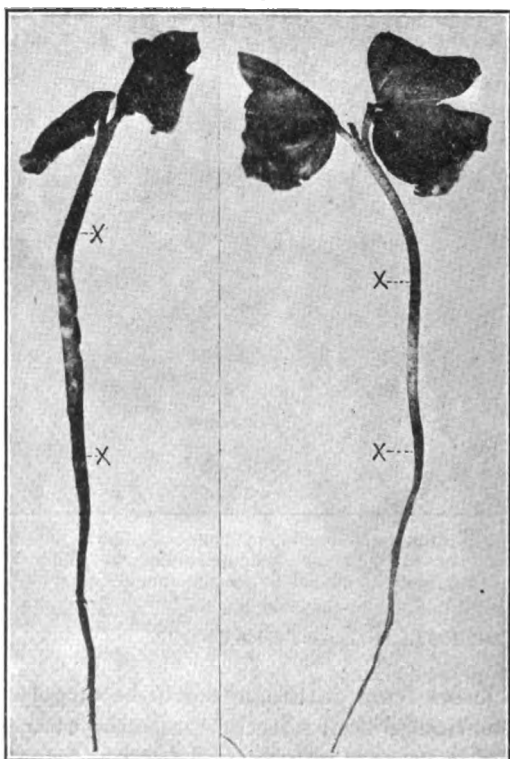


FIG. 10.—Cotton seedlings attacked by anthracnose. Note the blackened diseased areas at X.

ANTHRACNOSE CAUSED BY A FUNGUS.

Anthracnose is caused by a fungus² which grows into the bolls.

stems, and leaves and kills their tissues, thus producing the rotten spots or dead areas. The fungus produces spores or tiny seeds in sticky masses on the diseased bolls and stems, giving the centers of the spots a pink color. By means of these the disease is spread from field to field and from plant to plant.

² *Glomerella gossypii*.

BACTERIAL BLIGHT.**APPEARANCE ON BOLLS, STEMS, AND LEAVES.**

The only bacterial disease of cotton which is at present of economic importance is variously known as bacterial blight, bacterial boll-rot, angular leaf-spot, and black-arm, depending on the part of the plant attacked. The phase of the disease which results in much of the money loss to the crop is the attack on the bolls commonly known as boll-rot. The first signs of this trouble are small dark-green, water-soaked, roundish spots on the bolls (fig. 11, *A*), which gradually enlarge and turn black in the center as the tissues are killed and shrink (fig. 11, *B*). Frequently two or three locks or the entire boll are so injured that they fail to open, or if they do open the cotton produced is discolored and rotten (fig. 11, *C*). Often

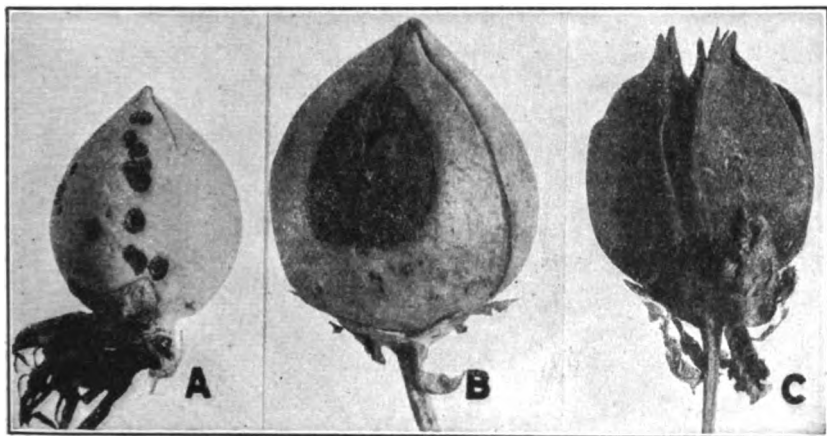


FIG. 11.—Bacterial boll-rot: *A*, Early; *B*, intermediate; and *C*, late stages.

the boll stem is attacked and killed, so that the boll dries up and falls off before maturity or fails to open.

The most general and conspicuous evidence of the disease occurs on the leaves, where it produces spots which are at first dark green, water soaked, and angular, bounded by the small veins. The spots are one-eighth to one-fourth of an inch in diameter and scattered over the leaves, often forming elongated diseased areas near the larger veins. Later they become dry, dark reddish brown to black, and sunken in the center and have a rusty red border. As the disease progresses the spots run together and increase in size. When severely attacked the leaves frequently turn yellow, curl up, and fall off. This phase of the trouble is usually called angular leaf-spot (fig. 12).

Black-arm is the name commonly applied to the disease when it attacks the stems of cotton plants, because the skin of the branches

is killed and they turn black. Frequently this phase of the disease is complicated by the secondary occurrence of the anthracnose fungus, which produces an abundance of pink spores on the blackened branches. Black-arm so weakens the stems that they may drop their bolls while still immature, or the stalks and fruiting branches may be broken off by storms (fig. 13). In severe cases entire plants are killed and the yield very seriously reduced. This is particularly

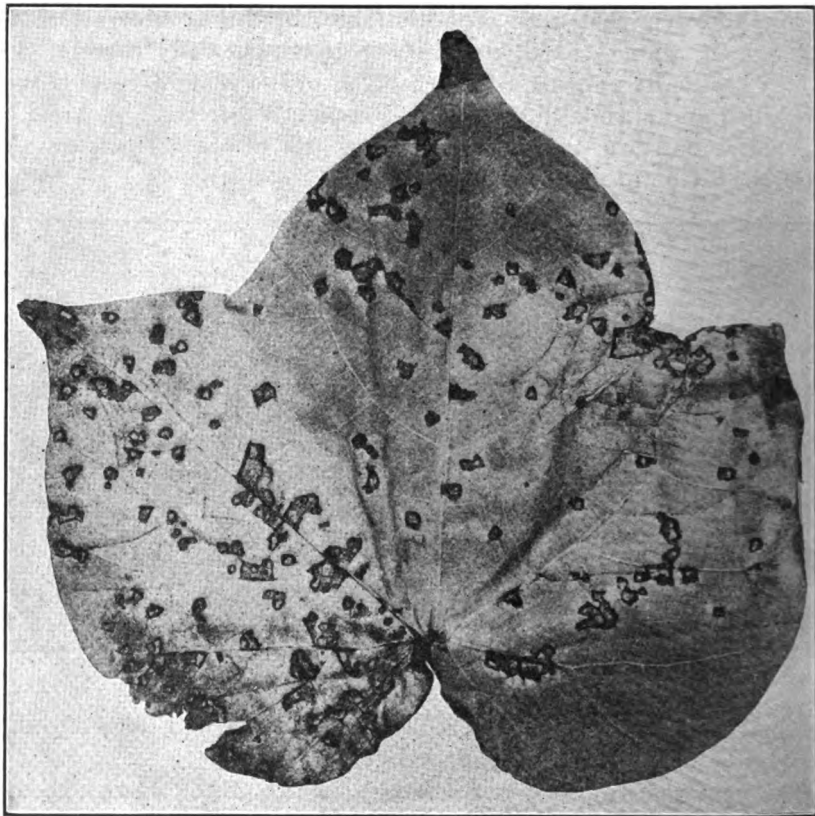


FIG. 12.—Angular leaf-spot of cotton. Many spots are bounded by the small veins.

true with Egyptian and Sea Island cottons, which are especially susceptible to the disease. This is also one of the principal reasons why Egyptian cotton has not been profitably grown in the Southeastern States.

On the young seed leaves the spots resemble those on the bolls, being round, water soaked, and green at first, but later becoming black.

HOW TO CONTROL BLIGHT.

The best method now known of controlling the bacterial blight of cotton involves the use of disease-free seed combined with

crop rotation. While crop rotation may not be as important a factor in controlling bacterial blight as originally thought, since it has been found that the disease apparently does not live over in the soil of diseased fields to a serious extent, nevertheless rotation is important as a general farming procedure

**ROTATE CROPS. SELECT
DISEASE-FREE SEEDS.**

and is valuable in the control of other diseases, such as anthracnose, and therefore should be regularly practiced.

It is known that the disease may live over winter on the seed to a certain extent, and it is therefore important that careful seed selection

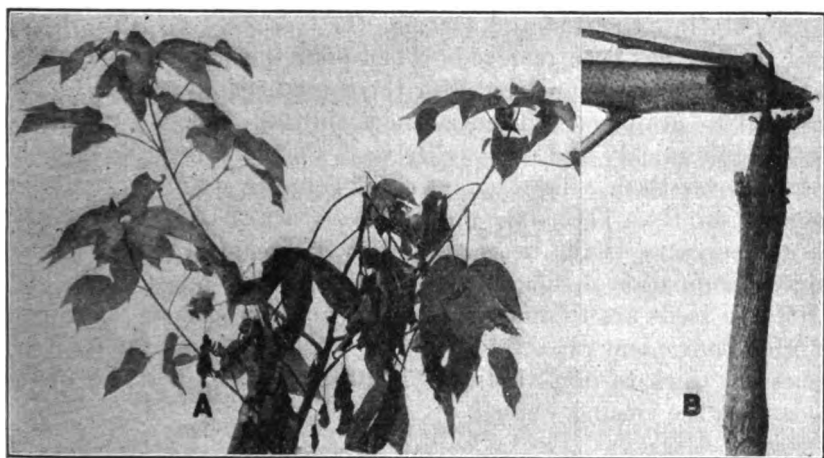


FIG. 13.—Serious loss from “black-arm” results from the breaking of diseased branches during storms: A, An injured plant; B, a broken diseased branch (enlarged).

should be a regular part of good cotton-farming practice in order that only healthy seed be saved for planting. Seed should be saved only from fields where the disease does not occur, or if this is impossible, owing to its general prevalence, it should be taken from the least-affected fields or portions of fields or be secured from some other farm or locality where the disease has not been so severe.

METHOD OF SEED TREATMENT.

Under special conditions where it is desired to plant small quantities of valuable seed which came from badly diseased fields, treatment with sulphuric acid, mercuric chlorid, or hot water may be used to advantage to free the seed from disease germs, but seed treatment is not advised as a general farm practice.

The treatment of cotton seed is complicated by the presence of the fuzz, which, because of the air it holds, prevents the ordinary dis-

infectants, such as mercuric chlorid and formaldehyde, from coming in contact with the surface of the seed and thus thoroughly sterilizing it. For this reason it is necessary to use concentrated sulphuric acid to remove the fuzz. Because of the extremely caustic nature of this acid it should be used only by those who have had experience in handling it. For this treatment wooden tubs coated on the inside with melted roofing pitch have been found satisfactory, as the pitch is very resistant to the action of the acid. Three tubs should be provided, one of which has the bottom very closely perforated with quarter-inch holes, to furnish a sieve for draining off the acid and to assist in washing the seed after treatment.

Place the seeds to be treated in one of the tubs and pour enough concentrated acid over them to wet them completely. Stir the seeds thoroughly into the acid and continue the treatment 8 to 10 minutes until the lint has been removed. Then pour the seeds and acid into the perforated tub, supported over the second coated tub, and allow the acid to drain out. Then support the tub over a hole in the ground and quickly and thoroughly wash the acid from the seeds by pouring over them a large quantity of running water and stirring them constantly. This is the most critical part of the operation, for the temperature of the mass of seeds will become high enough to injure germination if sufficient water is not added to keep them cool. After the seeds are thoroughly washed spread them out on a roof or other convenient place to dry. The acid may be used until it becomes too thick to pass through the sieve; then wash it out of the seeds with the rinsing water.

DISTRIBUTION AND LOSS.

Bacterial blight occurs very generally throughout the cotton belt from Virginia to Texas and also in the southwestern cotton areas especially in Arizona. It appears to be more general and severe on the Coastal Plain than in the Piedmont region. Its occurrence in sufficient amount and seriousness to cause important crop injury depends on favorable weather conditions and varietal susceptibility. Dry weather checks the disease, while rainy weather is especially favorable to its rapid spread. In fact, wind during rainstorms is one of the most important agents in the dissemination of the blight.

There may be no loss from blight or the losses may aggregate 75 per cent or more in especially severe cases. Upland cotton in general is relatively resistant to damage as compared with Sea Island and Egyptian, most varieties of which are especially susceptible. Losses result from leaf shedding, from boll rotting, and from the killing or breaking of branches which have been attacked. The leaf-spot and dropping are probably the least serious phases of the disease, and the

boll-rot is the most injurious in Upland cotton. In Sea Island and Egyptian varieties black-arm is important and adds to the damage caused by boll-rot.

In the Eastern States a reduction of the yield by 5 per cent or more would be considered the exception, while an average injury of about 1 per cent is estimated on Upland cotton. On Egyptian cotton in the Salt River Valley, Ariz., the losses from the black-arm and boll-rot in 1918 and 1919 varied from 0 to 65 per cent, with an estimated average of 15 per cent.

BLIGHT CAUSED BY A GERM.

Blight is caused by a bacterium, or germ,^{*} which enters the leaves, stems, and bolls through the breathing pores and kills the cells near by, producing spots on the leaves, dead areas on the branches, and the decay of the bolls.

The disease appears first on the cotyledons, or young stems, early in the season. Later on, if favorable weather conditions occur, it spreads to the leaves, bolls, and branches, causing the various phases of the trouble already described. One of the most effective agents in spreading the disease germs is wind-blown rain.

The causal organism of the disease lives over winter in or on the seed, and possibly on diseased parts of the cotton plant left in the field or plowed under in the fall.

SHEDDING OF BOLLS.

NATURE AND OCCURRENCE OF SHEDDING.

Shedding is the name commonly given to the premature dropping of cotton squares or young bolls at any time during the season. It does not include the dropping of bolls due to damage by weevils or other insects. It is not a disease in the usual sense of the word, but the large annual losses caused by it make it seem desirable to include a brief discussion of the trouble. Shedding occurs every season to a greater or less degree in every cotton field, and in the aggregate the loss from shedding is greater than that from all the cotton diseases combined. The cotton plant produces a larger crop of flowers than it can mature even under the most favorable growing conditions, and the percentage of those which are subsequently shed depends on the character of the succeeding season. There is also some variation among the different varieties as to the number of bolls shed. The results of careful records of the number of bolls shed by a thousand plants made by Ewing in Mississippi during a season when soil and weather conditions were very favorable indicates that losses of

^{*} *Bacterium malvacearum.*

40 to 60 per cent of the bolls by shedding is a fairly common occurrence. Under exceptionally favorable weather conditions the losses may be less and under adverse conditions greater.

Shedding generally begins a week or more after the first flowers have bloomed and occurs usually in increasing degree up to the middle of August, when it decreases to the end of the season. Careful records indicate that in this country comparatively few flower buds or flowers are shed except under unusual conditions, but that by far the larger number of shed bolls are dropped within a period of two weeks after the opening of the flowers. This period of persistence of the shed bolls varies with different varieties and at different stages in the fruiting season. It is usually longest early in the summer, sometimes as much as 19 days, and shortest toward the close of the season, when four to five days is the average.

In most varieties the dead bolls fall to the ground, but in the cluster varieties it is more usual for them to remain attached to the plant. This fact accounts for the general impression that cluster varieties are more subject than other cottons to shedding injury.

The first indication of shedding is a gradual fading of the normal green color of all parts of the boll. In varieties which retain the bolls they soon become pale yellow or straw color, dry up, and may remain attached to the plant until the end of the season.

CAUSE OF SHEDDING.

The shedding of cotton bolls may be due to one or more of many causes, among which may be noted the following: High temperatures, resulting in high transpiration and evaporation and consequent low soil moisture; heavy and continuous rains; abrupt changes in weather conditions from wet to dry, cloudy to clear, cool to hot, or the opposite; imperfect pollination due to rainy weather; and root injury due to too deep cultivation late in the season.

Experimental workers agree that shedding is most closely related to the water supply of the plant. Barre has shown that the water requirements of cotton in South Carolina are largest during the month of August, and this is also the time when the temperatures are highest and the soil-moisture content lowest. Lack of sufficient soil moisture is the principal factor causing cotton shedding.

Shedding may be regarded as a means by which the plant adjusts itself to changed growing conditions. During the early part of many seasons the temperature and moisture conditions are usually more favorable to vegetative growth than later, and hence the cotton plant produces a larger weed and sets more flowers than it can maintain during the latter part of the season when temperatures are higher, soil moisture less, and, in many instances, readily available plant food

is used up, and when the fruiting activities of the plant are more exacting on the food and water supply. Consequently, when these conditions of increased demand and decreasing supply of food and water arrive, the plant meets them by shedding bolls until a point is reached where the remainder can be matured under the less favorable growth conditions. This process of adjustment to meet changed conditions is continuous, and hence the amount of shedding varies from time to time. In cases of extreme drought bolls of considerable size may be shed.

On the other hand, water-logging of the soil due to lack of drainage and excessive and continuous rainfall may also result in a considerable amount of shedding.

CONTROL OF SHEDDING.

Since the lack of soil moisture during the latter part of the season is the principal cause of shedding, methods of conserving the water supply will help to reduce the losses. The most important methods are (1) building up the vegetable-matter content of the soil by crop rotations, by plowing under green-manure crops, or by the addition

**ADD HUMUS TO THE SOIL.
CULTIVATE SHALLOW
LATE IN THE SEASON.**

of liberal quantities of stable manure; and (2) shallow cultivation in order to retain a loose soil mulch to prevent evaporation, as long as it can

be done without injury to the plants.

Avoid injuring the cotton roots by deep cultivation late in the season. Drain wet fields to reduce water-logging in rainy seasons.

RUST.

OCCURRENCE AND LOSSES.

One of the most common and serious troubles affecting cotton on the poorer soils throughout the cotton belt is generally known as rust. Other names are black rust, yellow leaf-blight, and potash hunger. It occurs quite generally on the worn-out and light sandy soils, and in the aggregate the losses are large. In 1918 the trouble was reported as causing the most serious losses in the Coastal Plain regions of South Carolina, North Carolina, Georgia, and Alabama, and also locally in Mississippi and Louisiana and on the "buckshot" lands of Arkansas.

The losses range from slight to as much as 50 or 60 per cent, with an estimated average for the entire cotton belt of 4 to 5 per cent.

HOW TO RECOGNIZE RUST.

Cotton fields affected by the common rust do not usually produce normal growth. The plants are small and lack a healthy green color. The leaves first begin to show a yellowish mottled appearance about the middle of the season, the parts near the veins remaining green longest, while the tissues between the veins, and hence farthest from the food supply, turn yellow. They later take on a reddish brown color, curl up, and drop off, leaving the stalk bare. The top bolls of such plants either fail to set or mature imperfectly, so that the lint produced is short and of inferior quality.

The trouble is usually noted in definite spots or irregular areas in affected fields (fig. 14), and unless remedial measures are applied may recur year after year in the same places.

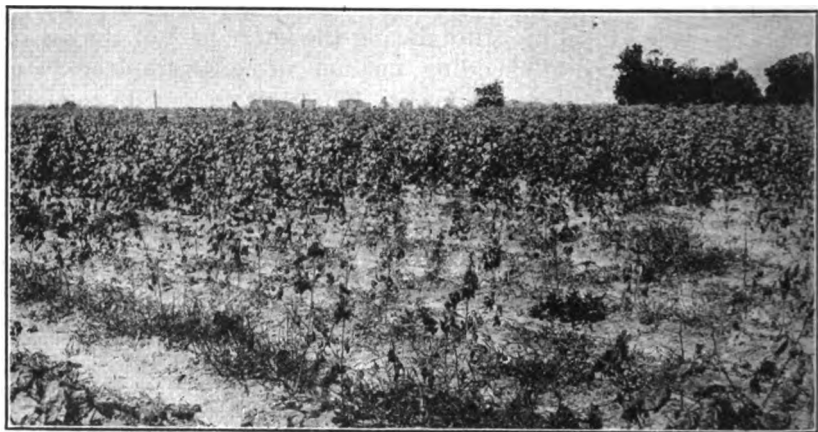


FIG. 14.—Cotton rust appears in irregular spots in the fields, where but little cotton is produced.

This disease is liable to be confused with certain other cotton troubles, especially with the true rust caused by a fungus attacking the leaves (described on p. 31) and with injury caused by red-spider attacks. Red-spider injury is also referred to as red-rust. These mites attack and cause a reddening of a part or all of the leaf. In extreme cases defoliation of affected plants results. The mature red spiders or the yellowish younger ones, together with their fine webs, can usually be found on the under side of the discolored leaves, and thus the trouble can be distinguished from rust.

CONTROL OF RUST.

Cotton fields which show general and severe rusting are usually in need of rotation with other crops in order to build up the humus supply which has been exhausted by continuous cotton cropping. The plowing under of green-manure crops, such as rye, cowpeas,

and velvet beans, or the addition of a liberal application of stable manure will do much to improve soil conditions and prevent rust.

**SUPPLY VEGETABLE MATTER
TO THE SOIL. USE FERTILIZERS
CONTAINING POTASH. DRAIN
THE WET FIELDS.**

The use of kainit at the rate of 200 pounds per acre, or of 50 pounds per acre of muriate of potash, or the application of

other potash-containing fertilizers will also help reduce rust damage.

CAUSE OF RUST.

Rust is a reaction of the cotton plant to soil conditions unfavorable to normal growth and development. It is not due to the attack of any disease-producing organism or to injury by insects.

The most common causes for rust are lack of humus or vegetable matter in the soil, lack of potash, and lack of drainage. Many fields with naturally light or poor soils are planted to cotton year after year with little or no attention to keeping up the supply of vegetable matter which is essential to vigorous growth. The result is an increasing occurrence of rust the longer the practice is maintained. Such soils are also usually deficient in potash, and if it is not supplied in sufficient amounts in the fertilizers rust will develop when the supply furnished is used up by the plant. Rust, or potash hunger, has been more general and serious the past few years, owing to the difficulty of securing the normal supply of potash on account of the war.

Rust often develops in poorly drained fields or in low spots, while higher parts are free from it. Likewise, some fields may develop rust as a result of heavy and continuous rains in the latter part of the season.

SORE-SHIN.

The disease commonly called sore-shin attacks chiefly the small cotton seedlings, causing them to rot off partly or entirely at or near the surface of the ground. It sometimes causes considerable damage during cool wet periods early in the season by reducing the stand of plants so much that replanting is necessary or by so injuring the seedlings that growth is retarded and the normal development of the crop delayed. It rarely causes important damage in favorable seasons, owing to the general practice of very heavy seeding.

HOW TO RECOGNIZE SORE-SHIN.

The trouble is characterized by the presence of dark rusty brown sunken cankers on the seedling stems at or just below the surface of the soil. In severe cases these encircle the stem or penetrate so

deeply that the plants fall over and die. Many plants which have stem cankers but are not too severely affected recover on the arrival of warm dry weather and outgrow the injury, though somewhat delayed in development. Sore-shin must be distinguished from the damping-off due to anthracnose. In sore-shin more definite ulcers are formed; they are rusty brown in color and are generally found just at or below the soil surface. In anthracnose the injury is a more rapid damping-off, often occurring as long sunken reddish areas on the stem above ground, and it is usually associated with diseased spots on the seed leaves.

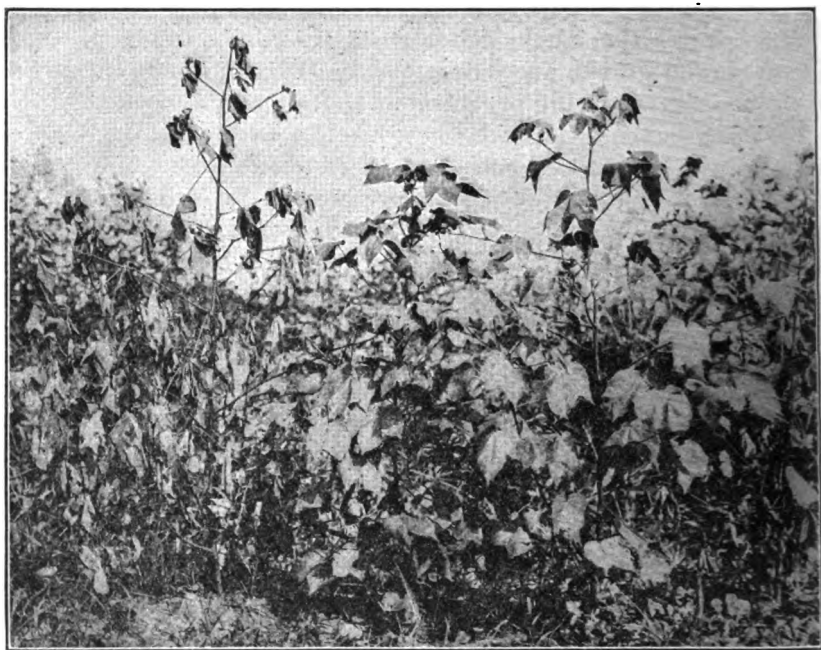


FIG. 15.—Cotton plant wilted by root-rot; two healthy plants stand beside it.

CONTROL OF SORE-SHIN.

No very satisfactory control methods are known. The best practice is to fertilize the plants adequately to start them off into vigorous growth and to cross harrow the rows with a weeder to allow the soil near the seedling stems to dry out as quickly as possible after wet periods.

SORE-SHIN CAUSED BY A SOIL FUNGUS.

Sore-shin is due to a fungus (*Rhizoctonia*) which lives in the soil and attacks the seedlings during cool moist weather. Because of the nature of the injury many farmers attribute the trouble to cuts or blows from a hoe or scraper.

TEXAS ROOT-ROT.**SIGNS OF THE DISEASE.**

The first indication of Texas root-rot is the sudden wilting of one or more cotton plants (fig. 15). This is usually noted the latter part of June or early in July, though cases have been noticed early in May. Following these first cases other plants near by or in other parts of the field continue to wilt and die throughout the season. By October rounded patches or irregular areas of considerable extent may be found where the cotton stalks are dead and reddish brown (fig. 16). The suddenness of the wilting and death of affected plants is very noticeable, as are the brown areas of dead plants in comparison with the remaining parts of the field, which are still green and healthy. The rate of wilting is somewhat dependent on weather conditions, the disease progressing more rapidly during



FIG. 16.—A root-rot spot in a cotton field, showing dead, wilted, and healthy plants.

warm days immediately following rainy weather than during dry periods. The wilted plants become entirely dry in 12 to 24 hours of sunshiny weather.

Aboveground symptoms prior to wilting are not readily noted. No appreciable dwarfing of the plant or yellowing of the foliage is present, such as characterize plants attacked by wilt or black-root (p. 3).

The roots are usually covered at first with a whitish mold, which later becomes yellowish brown. This results from the growth of the fungus which causes the disease. The taproot is usually attacked first near the surface of the ground. Affected roots are generally slightly shrunk, and the sunken, diseased areas are at first bordered by a reddish discoloration, which later becomes brown. Often there is a slight enlargement of the stem of the plant above the diseased part of the taproot and near the soil surface, from which

new secondary roots are put out to take the place of the diseased ones. It is quite common to find the taproot entirely dead from root-rot and a single lateral root abnormally developed to support the plant (fig. 17).

Apparently healthy plants adjacent to wilted ones may have their roots covered with the fungous growth, which may later kill them. The affected areas in fields usually enlarge from year to year by the growth of the fungus through the soil, by means of diseased soil carried on tools, or by other agencies. There are some indications that the disease dies out to a certain extent in the center of diseased spots while advancing at the outer edge, in a manner similar to that characteristic of the well-known "fairy rings."

CONTROL MEASURES.

Texas root-rot is difficult to control, and no entirely satisfactory methods are known. The

**PLOW DEEPLY IN THE FALL.
ROTATE CROPS.**

best-known measures for reducing losses from the disease

combine crop rotation and deep fall plowing.

Since the disease attacks numerous crops besides cotton and also certain weeds, the following list is given of plants susceptible and resistant to Texas root-rot. Susceptible crops should not be grown on land affected with the disease. Crops resistant to root-rot should be made the basis of rotations for controlling the disease.

Plants attacked by Texas root-rot.

Cotton.
Soy beans.
Cowpeas.
Sweet potatoes.
Alfalfa.
Most nursery stock and fruit trees.
Many shade trees.
Beets and other vegetables.

Crops immune to Texas root-rot.

Corn.
Sorghums.
Millet.
Wheat.
Oats.
Other grains.

Combined with crop rotation, deep fall plowing to effect a thorough aeration of the soil should be occasionally practiced when the diseased land can be worked without injury to its physical condition. The land should be plowed late in November or early in December to a depth of 7 to 9 inches and left exposed to the weather during the winter. A 3-year rotation, using corn, grains, and sorghums, has been found most effective in reducing root-rot damage, though shorter rotations will give a certain measure of relief.

DISTRIBUTION, DAMAGE, AND SPREAD.

The occurrence of Texas root-rot on cotton is confined to the Southwestern States, Texas, Oklahoma, Arkansas, Arizona, New

Mexico, and southern California. In Texas it is most serious on the black-waxy limestone soils, which ordinarily are poorly drained and aerated, though it also occurs on other soils. Its spread northward and eastward is apparently limited by soil types and by low winter temperatures, which appear to kill the causal fungus. Root-rot may spread in the field quite rapidly during favorable seasons, probably by direct growth of the causal fungus through the soil, by soil adhering to tools or animals, and on bits of soil scattered by the wind. It is probably carried from diseased fields to healthy ones by the transfer of soil, such as takes place when soil inoculated with the nitrogen-gathering organisms is taken from an old alfalfa field to a new location where an alfalfa crop is to be started. This practice should be discouraged, since the root-rot is injurious not only to cotton but to alfalfa and will undoubtedly lead to more rapid spread of the trouble.

The damage from root-rot varies from slight to very severe. Sometimes the disease attacks the plants so late in the

season that a fair crop is matured before they die, but in most cases the yield of diseased plants is materially reduced and the quality of the lint is inferior, while plants killed early in the season produce no cotton. In Texas, root-rot is the most destructive disease of cotton, some planters regarding it a more serious menace to the crop than the cotton boll weevil. The fact that it attacks several other crops besides cotton adds to the damage which it may cause. In 1906 the

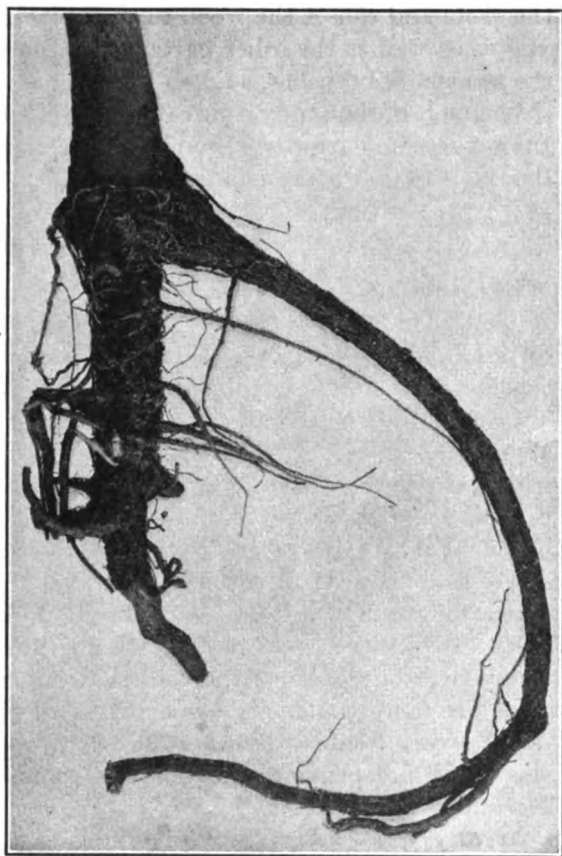


FIG. 17.—Root system of a cotton plant attacked by root-rot, showing its taproot killed and a lateral root developed to support the plant.

loss from root-rot in Texas alone was estimated at 52,600 bales, or 1.3 per cent of the crop. The disease is found to an increasing extent in the newly-developed cotton areas in New Mexico and Arizona.

ROOT-ROT CAUSED BY A SOIL FUNGUS.

Root-rot is attributed to a fungus⁴ which lives in the soil and attacks and kills the roots of cotton and other plants. It penetrates the roots and causes the wood to turn black. It grows in the water vessels as well as the other parts of the roots, but does not spread to the stems and branches, as does the fungus which causes wilt (p. 4), so common in the sandy soils of the southeastern Cotton States. The fungus seems to grow best, and hence the disease is most severe, where the soil aeration is the poorest.

MINOR DISEASES.

In addition to the more important cotton diseases already described there are several other troubles which each year cause a certain amount of damage that is difficult to estimate. They are not considered of major importance, but are worthy of brief mention.

Leaf-spot of cotton is caused by a fungus⁵ which produces an abundance of rather small roundish to irregular spots which are white in the center, with a reddish brown border. This leaf-spot is seen in nearly every cotton field toward the end of the season. It is doubtful whether it causes appreciable damage, except when so severe as to cause defoliation.

Leaf-blight is due to the attacks of a fungus⁶ which produces rusty brown dead spots one-fourth to three-fourths of an inch in diameter, of irregular shape, and showing concentric ridges. These spots are more commonly associated with the angular leaf-spot injuries or are found in areas attacked by red spiders, but they may also occur independently. It is less common than the *Cercospora* leaf-spot.

Areolate mildew, or frosty blight, produces small scattered angular spots which are usually frosty white on the under side of the leaves (fig. 18), due to the fruiting bodies of the causal fungus,⁷ while from the upper side the diseased areas are sometimes reddish and sometimes white. This disease occurs occasionally toward the end of the season, especially on the leaves of plants growing in moist places, and in the more severe cases causes partial defoliation. It is of less general occurrence and of less importance than *Cercospora* leaf-spot.

⁴ *Ozonium omnivorum*.

⁵ *Cercospora gossypina*.

⁶ *Alternaria* sp.

⁷ *Ramularia areola*.

True rust is a fungous^a disease of very general occurrence in the West Indies, but which has been reported only once from this country. It is characterized by the presence on the leaves of numero

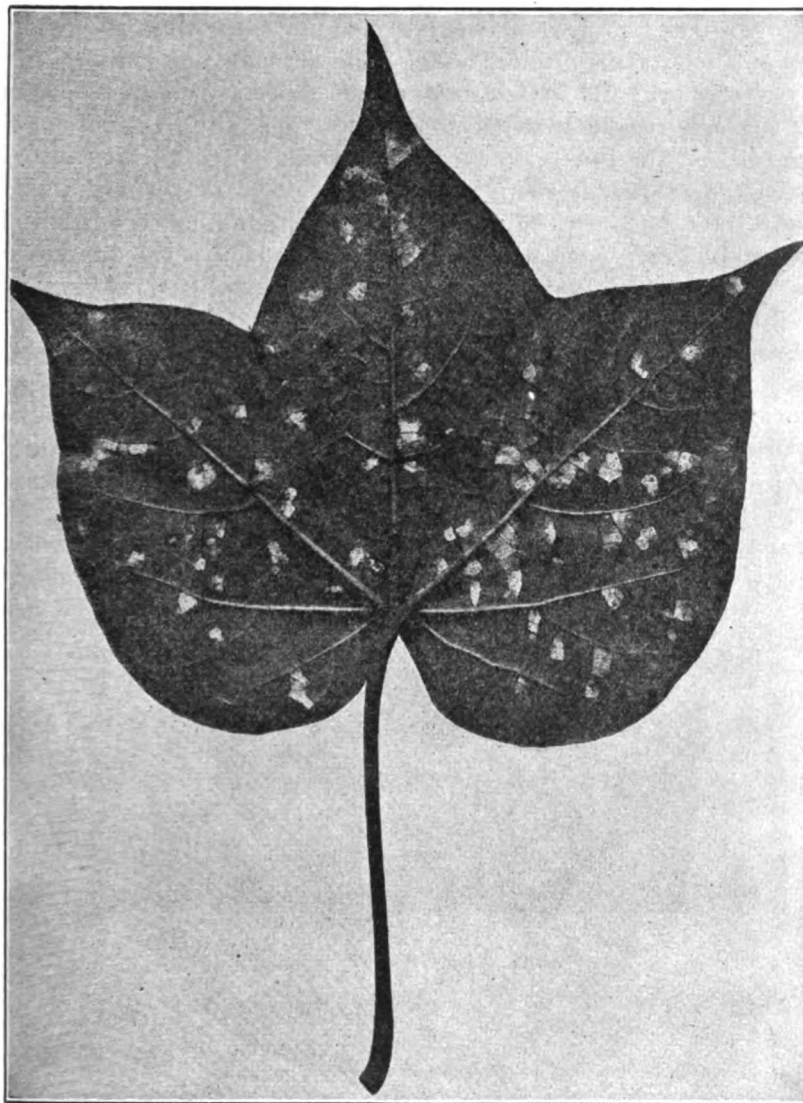


FIG. 18.—Under side of a cotton leaf attacked by areolate mildew, or frosty blight.

slightly raised, rusty-brown circular spots about the size of a pin head. It is distinctly different from the disease commonly called rust, which is described on page 24.

^a *Uredo gossypii*.

Diplodia boll-rot is reported as causing as high as 10 per cent loss in occasional fields in Louisiana, with an estimated average of 2 per cent loss for the State, though it is not so abundant in the eastern Cotton States. It is caused by a fungus* which enters the boll through insect injuries or wounds made by other diseases, but it is not able to attack uninjured bolls. Affected bolls first become brown, then jet black, and are covered with a powdery coating of spores. When bolls become infected, the rot develops rapidly, involving the entire boll; the lint is decayed and blackened and of no value. It occurs most often on the lower bolls near or in contact with the soil. Crop rotation is advised where the rot becomes important, since the causal fungus is known to live over winter in the soil on decaying bolls and stalks.

Fusarium boll-rot also occurs on bolls injured by insects or other diseases and is especially prevalent in wet weather. It is usually recognized by an abundant covering of pink spores. It is distinguished from anthracnose boll-rot by the fact that anthracnose spores are borne in sticky masses, usually on the central part of the spot, while *Fusarium* spores are lighter pink and are produced in powdery masses over the entire surface of the decayed area. The disease is not of great importance except in wet seasons, when it causes the rotting of a good many injured bolls. The fungus lives over winter in the field and on the seed and also attacks the young seedlings.

* *Diplodia gossypina*.



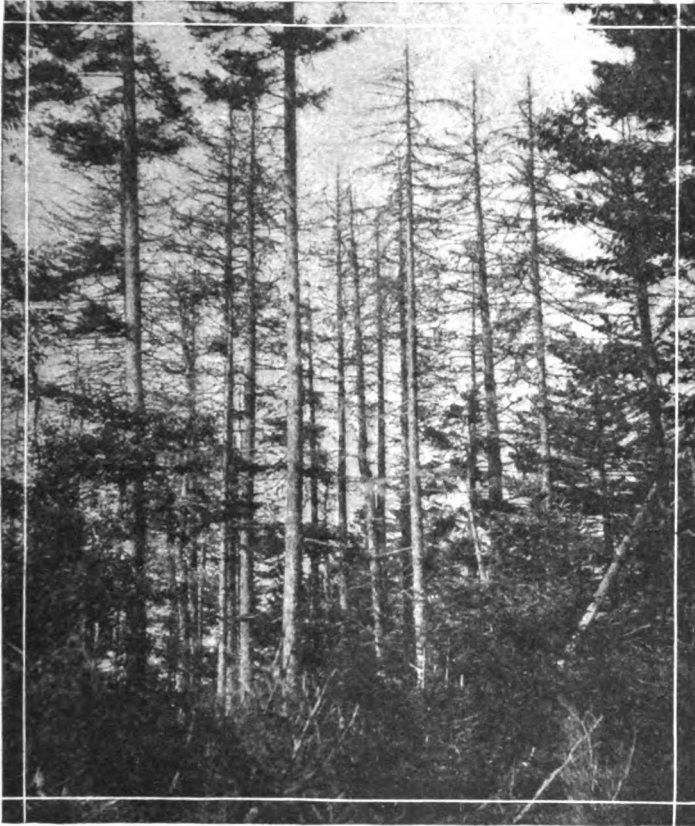
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THE SOUTHERN PINE BEETLE

A Menace to the Pine Timber of the Southern States

A. D. HOPKINS

Forest Entomologist, in Charge of Forest Insect Investigations



FARMERS' BULLETIN 1188

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief

Washington, D. C.

March, 1921

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1921

THE SOUTHERN PINE BEETLE is the most destructive enemy of the pines of all species in the Southern States from Pennsylvania to Texas. It has killed more merchantable-sized timber during the last 30 years than has died from all other causes combined. Between 1890 and 1893 it killed a very large percentage of the yellow, pitch, and white pines of West Virginia and Virginia, and, since the earliest records in 1842, has killed a vast amount of timber in the Atlantic and Gulf States, most of which has been a total loss.

The prevention of serious outbreaks and the control of this menace to the great timber resources of the South are not only possible but entirely practicable. It is only necessary to cut, and utilize for fuel or lumber during the fall and winter months, all trees that die during the late summer and fall, making sure that the bark of the main trunk is burned.

THE SOUTHERN PINE BEETLE:¹

A MENACE TO THE PINE TIMBER OF THE SOUTHERN STATES.

By A. D. HOPKINS,

Forest Entomologist, in charge of Forest Insect Investigations.

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THE SOUTHERN PINE BEETLE: WHAT IT IS AND WHAT IT DOES.

THE SOUTHERN PINE BEETLE is a small brownish or black beetle, somewhat smaller than a grain of rice. It flies from March to December in the more southern sections, and from May to November in its northern range. It attacks the middle to upper portions of the trunks of healthy pine trees, causing their death by excavating long, winding burrows, or egg galleries (figs. 1 and 3), which extend through the inner layers of the living bark and mark the surface of the wood (fig. 2). Eggs are deposited along the sides of these galleries, from which young grubs (larvæ) hatch and then feed on the inner bark until they have attained the size of the parent beetles, when they mine into the outer bark and transform to the dormant (pupal) stage, and later to the adult or beetle stage. The beetles then emerge to fly in search of other living trees, in which this process of attack and development is repeated.

The winter is passed in the bark of the living and dying trees in all stages of development. The more advanced individuals begin to emerge and fly in March to May, and the remainder continue to develop and emerge until about the last of July, so that by this

¹ *Dendroctonus frontalis* Zimm.; order Coleoptera, family Ipsidae.

time all of the trees that were attacked during the previous fall and early winter are dead and abandoned by the beetles.

From three to five generations occur annually. The first generation begins with the eggs deposited by the first beetles that fly and attack the trees in the spring and by those of the overwintered broods as they make successive attacks during the spring and early summer.

The second generation begins with the eggs deposited by the adults of the first generation, and so on until cold weather stops their activities.

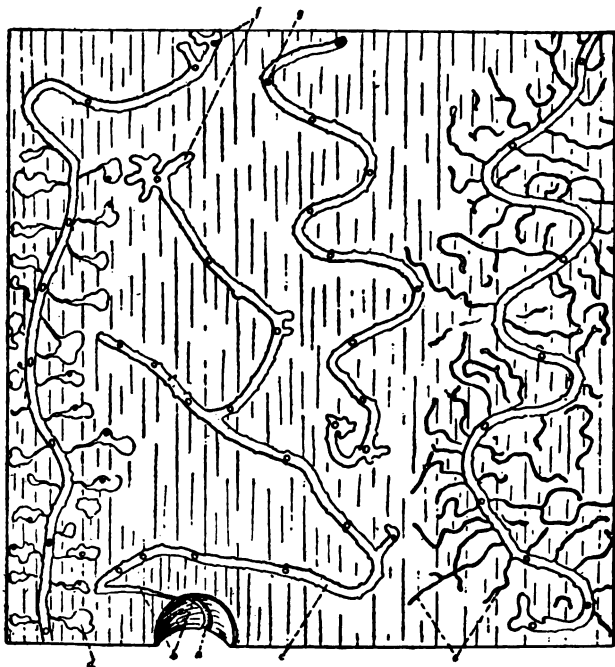


FIG. 1.—Egg galleries and larval mines of the southern pine beetle: *a*, Entrance; *b*, entrance burrow; *c*, egg gallery; *d*, normal larval mine; *e*, abnormal larval mine; *f*, terminal; *g*, ventilating burrows. Slightly reduced.

At all times there is a more or less complex overlapping of generations, so that emergence and attack are continuous during the entire period of activity; consequently, there is a continuous dying of trees within the infested areas.

Under average or normal conditions of the activities of this beetle a few scattering trees are killed by it each year in mature stands of pine timber throughout the Southern States where the pine is common. If, however, from any cause, conditions become favorable for the multiplication of the insect, it is able to kill groups of trees, and if these groups increase in number and size the following year

they constitute the danger signal of an outbreak which may result in widespread devastations. The southern pine beetle is the most destructive enemy of the pine within its range; in fact, it is a constant menace to the living pine of all the Southern States. (See fig. 4.)

EVIDENCE OF THE DESTRUCTIVE WORK OF THE BEETLE.

The presence of this beetle in dangerous or destructive numbers is plainly indicated by patches of dying and dead pine, which show no evidence of injury by fire or other destructive agencies.

The trees infested by the developing broods are indicated by the fading green, greenish brown, and yellowish red of the foliage and positively determined by the removal of some bark from the *middle* of the trunks of a few of the dying trees and the finding of the characteristic work in the inner bark and on the surface of the wood, as shown in figures 2 and 3.

The trees which have been killed and abandoned by the developed broods of the beetles are indicated by the reddish-brown foliage (abandoned "red tops"), the fallen foliage (abandoned "black tops"), and the decaying standing or fallen trees (abandoned "broken tops" and "snags," fallen trees, etc.). The cause of the death of trees of any of these stages is determined by examining the dead bark for evidence of the work of the beetle.



FIG. 2.—Section of pine trunk with bark removed, showing the marks of the egg galleries on the surface.

EXTENT OF LOSSES.

Extended observations in all of the Southern States between 1891 and 1911 led the writer to conclude that if all of the pine that has

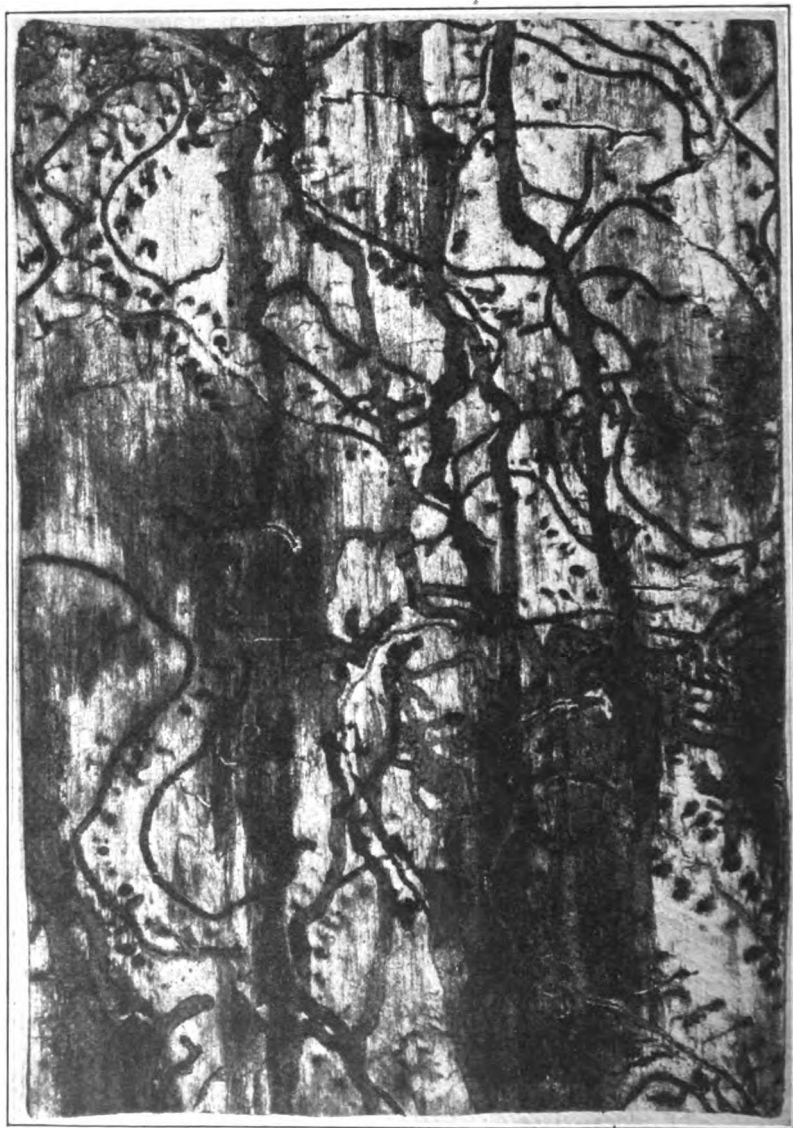


FIG. 3.—Bark from pine tree showing galleries of the southern pine beetle, which kills the trees, and the larger mines of the "sawyer," which does not kill trees.

been killed during this time by this beetle were living in 1911 its stumpage value would have amounted to from \$10,000,000 to \$20,000,000 or more. Studies of the depredations wrought by it in the

South Atlantic and Gulf States in the years 1908 to 1911 indicate that at least \$2,000,000 worth of pine was killed during that time. It is evident that if active steps had not been taken in 1911 by the principal owners in the infested areas this loss would have increased to another million dollars within the next year.

Since 1911 no extensive outbreaks have been reported or observed, but there is constant danger that the beetle may again multiply to the danger point.

THE REMEDY.

It has been determined and demonstrated that if the larger part of the infestation within an area of 8 or 10 square miles is disposed of according to the methods discovered and recommended by the

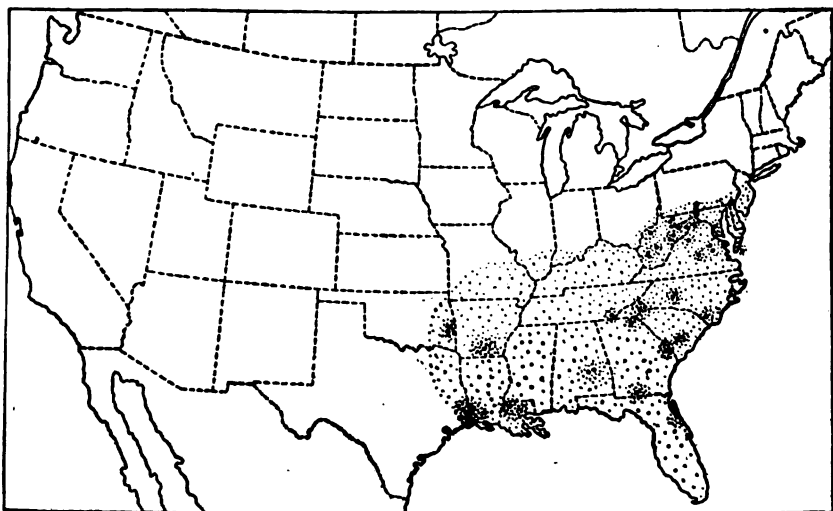


FIG. 4.—Map showing distribution of the southern pine beetle.

experts of the Bureau of Entomology it will bring the beetle under complete control in that area, and that thereafter control can be maintained with but slight trouble or expense. It is therefore evident that if the recommended methods are adopted and properly carried out the beetle can be controlled in any given community, district, county, State, or in the entire South.

Broadly stated, the method of control is to locate the infested trees during November, December, January, February, and March and destroy the overwintering broods in the bark of the main trunks, according to the recommendations on pages 10 to 13 of this bulletin.

THE COST OF CONTROL.

Experience has shown that while a large amount of timber may be dead in a given locality it may be an accumulation of several years or months through the continued dying of the trees, so that only a

comparatively few infested trees are found at any given time. Therefore if this small number of dying and infested trees is disposed of at the proper time and in the proper manner the cause will be removed at small cost and the dying of the pines will stop.

The cost for the required treatment will ordinarily average about 30 cents per merchantable-sized tree.

Protecting the *living* pine of farmers' woodlots and small forests of average-infested areas of 10 to 15 square miles in the central Southern States through a direct control of the beetle will cost from 1 to 10 cents per acre for the first year and practically nothing thereafter for from 10 to 20 years.

The protection of the *living merchantable* pine within a similar average area will cost from 5 to 30 cents per thousand feet, board measure, or from $\frac{1}{2}$ cent to 10 cents per cord for the first year and practically nothing during the next 10 to 20 years.

If the treated timber can be utilized for fuel, lumber, or any other purpose involving a commercial value, the cost will be reduced to a minimum, and in many cases a direct profit will be derived from the sale of the treated product.

INVESTIGATIONS IN THE SOUTHERN STATES.

From time to time since 1842 there have been reports of more or less extensive dying of pine timber in the Southern States.

Extended investigations of the problem were begun by the entomologist of the West Virginia Experiment Station in 1891 and continued at intervals in West Virginia until 1901, and by the experts on forest insects of the Bureau of Entomology at different times and in all of the Southern States from July, 1902, until 1911.

The results of these investigations have shown that the death of a large percentage of the pine of Virginia and West Virginia in the period from 1890 to 1893 was due to an invasion of the southern pine beetle, which attacked the healthy trees and girdled and killed them by excavating long winding burrows beneath the living bark on the main trunks of the trees.

It has also been shown that this beetle has existed in the Southern States for at least 78 years, and there is good evidence that it has occupied this region from time immemorial, but it is only at comparatively long intervals that it increases to such numbers as to cause widespread depredations.

During the summer and fall of 1910 and the winter and spring of 1911 correspondents of the Bureau of Entomology in different sections of the South, and especially in the Atlantic and Gulf States, reported that the pine was dying in patches, and that in some places the trouble was alarming. Therefore it was made the subject of special investigation in May, June, and July, 1911, which resulted

in the location of a forest insect field station at Spartanburg, S. C., for the purpose of studying the character and extent of the depredations and conducting a campaign of instruction and demonstration on the proper methods for controlling the beetle and protecting the remaining living timber. This work was prosecuted in such a manner as to convince the majority of the owners of pine within the areas covered by the representatives of the Bureau of Entomology that the southern pine beetle is a menace to the pine forests of the Southern States. There was a general and widespread interest manifested throughout the worst affected sections, and there is evidence that sufficient action was taken by the owners, in the utilization or treatment of infested trees according to the recommendations, to protect the remaining living pine from further depredations.

CHARACTER AND RANGE OF DEPREDATIONS IN 1911.

The study in 1911 of the character and extent of the depredations by the southern pine beetle in South Carolina, Georgia, Alabama, North Carolina, Mississippi, Texas, Florida, Virginia, Louisiana, Maryland, Arkansas, Missouri, and Tennessee, and information conveyed by correspondents from all sections of the South, showed that in the aggregate a vast amount of timber had been killed by the southern pine beetle during 1910 and 1911. The dying and dead trees occurred as scattering individuals or in clumps, large patches, and in some places whole forests. All were more or less conspicuous by their fading, red, black, or denuded tops, plainly indicating the presence of the beetle or the progress of its work.

PATCHES OF DYING PINE A MENACE TO THE HEALTHY TREES.

It was found that each patch of dying trees, with their fading and greenish-brown tops, located anywhere in the Southern States is a menace to the living pine within a radius of 3 or 4 miles. The broods of the southern pine beetle developing in the bark of the trees of one such center of infestation may swarm in any direction and settle in the healthy timber. Thus one or more additional patches are killed, until nearly all of the large as well as the small pine over an extensive area is dead.

When these centers of infestation are numerous within the confines of a county, or even a larger section of territory, they can only be compared with the starting of so many forest fires; and, as has been demonstrated, they *may lead to far greater destruction of merchantable pine than has ever been recorded as resulting from fire in the Southern States.* Therefore they demand similar prompt and radical action on the part of the owners in order to protect their living pine.

THE MORE IMPORTANT EVIDENCES OF THE PRESENCE AND WORK OF THE BEETLE.

(1) If in clumps or patches of pine, where there is no plain evidence of serious injury by fire, the foliage fades to pale green and changes to yellowish and pale brown, it indicates that the trees are dying from the attack of the southern pine beetle and that the bark on such trees is infested with the developing broods of minute white grubs and transforming beetles. Therefore such infested trees are a *menace to the living trees*.

(2) If the trees have reddish brown and partially fallen foliage, or if all of the foliage has fallen, it indicates that the broods of beetles have emerged *and that such trees are no longer a menace to the living ones*.

(3) If the trees die during the period between the 1st of March and the 1st of October they will be abandoned by the broods of beetles within a few weeks after the foliage has begun to fade.

(4) If the trees begin to die during the period between the 1st of October and the 1st of December the broods of beetles will remain in the bark until the following March or April.

HOW TO LOCATE THE INFESTED TREES.

The location of trees that are infested by the southern pine beetle is the first and one of the most important things to be done before definite plans are made for the active work of cutting the trees. Some of the essential things to be remembered are as follows:

(1) The southern pine beetle attacks the upper and middle portions of the trunks of healthy trees.

(2) A freshly attacked tree may show pitch tubes on the trunk or reddish boring dust around the base, or there may be no external evidence of attack until the leaves have begun to fade.

(3) By the time the tops are faded and the bark on the middle and upper trunk is dead the broods of the beetle are in an advanced stage of development, yet at the same time the bark on the lower third of the trunk may be living and show no evidence of attack or may be attacked by other kinds of insects which are not responsible for the death of trees.

(4) As soon as the bark begins to die on any part of the trunk it is attacked by numerous other insects, including the adults of the "sawyer" borers which do not attack healthy trees. (See fig. 3.)

(5) By the time the tops have changed from pale green to greenish brown the broods of the southern pine beetle have nearly all developed to the stage when they enter the outer bark to transform to the adults.

(6) By the time the tops have changed to a reddish hue the broods have developed and are either emerging or have emerged.

(7) During the warm months the broods will develop and emerge from a tree within about 30 to 40 days after it is attacked.

(8) Trees attacked in November will usually carry the broods over winter. The foliage of some trees will fade and reach the reddish stage before spring; other trees attacked in December or later may not fade until the warm days of February, March, or April.

Therefore, in estimating the character and extent of an infestation within any given area, or in locating infested trees and marking them for utilization or treatment, one has only to consider those with fading or greenish brown foliage or the first stage of the yellowish red tops.

ESSENTIAL DETAILS IN METHODS OF CONTROL.

There are certain essential details in the recommended methods of combating the southern pine beetle which must be observed in order to avoid not only serious mistakes but possibly ultimate failure:

(a) The principal clumps or patches of *dying* trees which are actually infested by the broods of the destructive beetle, as indicated by the *fading and dying* foliage, or otherwise, should be located and marked during the months of November, December, January, and February. In order to do this work, proper experience or special instruction is required. Therefore, some one who has had instructions should have charge of the work in each important area in which control work is to be undertaken.

(b) *The broods of the beetle* in the bark of the *main trunks* of 50 to 75 per cent of the medium to larger sized dying infested trees within an area of 8 or 10 square miles or more must be destroyed in order to stop their depredations.

(c) The broods may be destroyed by *one or more* of the following methods, the work to be done between the 1st of November and the 1st of March.

(1) Removing and burning the infested bark from the trunks of the standing trees; or

(2) Removing and burning the infested bark from the trunks of the trees after they have been cut down; or

(3) Scorching the infested bark, or burning the wood with the bark after the trees are cut down; or

(4) Placing the infested portions of the trunks in water; or

(5) *Converting the trunks of the infested trees into cordwood and using the wood for fuel before the beetles leave the bark the following spring; or*

(6) *Converting the infested trees into lumber or other products and burning the slabs or bark.*

(d) It is not necessary to burn the tops or branches of treated trees or to cut and burn small infested saplings *if the larger infested trees are disposed of.*

(e) It is not necessary to remove or destroy the bark on the lower portion of the trunks or on the stumps if it is not infested with the destructive beetle, and it is not necessary to cut or treat dead trees from which the beetles have emerged.

(f) It is necessary and essential that the broods of the destructive beetle in the bark of any portion of the main trunks of the medium to larger sized dying infested trees of any given locality should be destroyed.

(g) If the wood of the infested trees can be utilized for fuel, lumber, or other purposes, its value should cover the cost of the work. If the work of felling and barking the trees is done at direct expense, the cost will average 20 to 30 cents per tree.

(h) The cost of protecting the living timber of any locality with average infestation should not exceed an average of from 1 to 5 cents per acre for the total area of pine-covered land, and if estimated on a basis of volume it should not cost over 2 cents per cord of the living timber protected.

(i) The best time to conduct control operations against the southern pine beetle is during the period between November 1 and March 1.

(j) If a pine tree standing among or near a grove of woods of living pine is either struck by lightning or felled and barked or split into cordwood *during the summer* and early fall, it will, as a rule, attract the beetles within a radius of three or four miles and result in the starting of a new center of infestation and in the death of a large number of trees. It is dangerous to cut pine trees in the summer months when the southern pine beetle is killing trees in the neighborhood.

(k) The principal owners of pine in each community should cooperate in the disposal of the required infestation, but should not undertake the work until *some one or more of the owners is sufficiently familiar with the essential details of the proper methods.*

REQUIREMENTS FOR SUCCESS.

To succeed in any effort to protect the living pine from the destructive attacks of the southern pine beetle the broods of the beetle in the bark of the main trunk of the dying infested trees must be destroyed before they leave the bark. This may be done by utilizing the infested trunk, adopting one or more of the methods given, or by treatment at direct expense in cases where the wood can not be utilized.

The attainment of the best success from the practical application of any of these methods will depend on their adaptation to local con-

ditions and requirements for disposing of the infested timber, and strict adherence to certain details which are absolutely necessary to the destruction of the broods.

From the 1st of November to the 1st of the following March is the period in which to locate and mark the trees that are actually infested and in which the marked trees should be utilized or treated to kill the broods. In northern localities the period may be extended to the 1st of May.

The method of destroying the broods which in each case is the most economical and effectual can be determined by the owners in each community if they are sufficiently informed on the essential facts.

Detailed advice, recommendations, or conclusions as to the most economical and effective method of procedure for any given area should be deferred until certain reliable information is at hand regarding the local condition as to (a) the character and extent of the infestation, (b) the interest manifested by the people of the community in the value to them of the pine and the importance of protecting it as the source of future revenue, (c) the assurance of the majority of the owners that concerted action will be taken according to a definite plan and purpose, and finally, if a demonstration is desired, that local facilities will be offered for its successful prosecution.

If the owners of pine will consider the protection of their timber from the standpoint of a common interest and will realize the necessity for concerted action in the control work, success will be assured.

**PUBLICATIONS RELATING TO INSECTS INJURIOUS TO FORESTS AND
FOREST PRODUCTS.**

AVAILABLE FOR FREE DISTRIBUTION.

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Carbon Disulphid as an Insecticide. (Farmers' Bulletin 799.)
Gipsy Moth and Brown-tail Moth and their Control. (Farmers' Bulletin 845.)
Common White Grubs. (Farmers' Bulletin 940.)
White Ants as Pests in the United States and Methods of Preventing their Damage. (Farmers' Bulletin 1037.)
California Oak Worm. (Farmers' Bulletin 1076.)
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Insect Damage to the Cones and Seeds of Pacific Coast Conifers. (Department Bulletin 95.)
Sequoia Pitch Moth, a Menace to Pine in Western Montana. (Department Bulletin 111.)
European pine-shoot Moth; a Serious Menace to the Pine Timber in America. (Department Bulletin 170.)
Hulsache Girdler. (Department Bulletin 184.)
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Cypress Bark Scale. (Department Bulletin 838.)

**FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING
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Report on Gipsy Moth Work in New England. 1915. (Department Bulletin 204.) Price 30 cents.
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Food plants of the Gipsy Moth in America. 1915. (Department Bulletin 250.) Price 10 cents.
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Dying Hickory Trees, Cause and Remedy. 1912. (Entomology Circular 144.) Price 5 cents.

- Insect Damage to Mine Props and Methods of Preventing Injury.** 1912. (Entomology Circular 156.) Price 5 cents.
- Gipsy Moth as Forest Insect, with Suggestions as to its Control.** 1913. (Entomology Circular 164.) Price 5 cents.
- Insect Enemies of Spruce in Northeast, with Recommendations for Preventing Losses.** 1901. (Entomology Bulletin 28, n. s.) Price 10 cents.
- Catalogue of Exhibit of Economic Entomology at Lewis and Clark Centennial Exposition, Portland, Oreg., 1905.** 1905. (Entomology Bulletin 53.) Price 10 cents.
- Black Hills Beetle, with Further Notes on Its Distribution, Life History, and Methods of Control.** 1905. (Entomology Bulletin 56.) Price 5 cents.
- Some Insects Injurious to Forests. 1906-1910.** (Entomology Bulletin 58, 5 pts.) Price 20 cents.
- Locust Borer.** 1906. (Entomology Bulletin 58, pt. I.) Price 5 cents.
- Western Pine-Destroying Bark Beetle.** 1906. (Entomology Bulletin 58, pt. II.) Price 10 cents.
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- Practical Information of Scolytid Beetles of North American Forests: 1, Bark Beetles of Genus Dendroctonus.** 1909. (Entomology Bulletin 83, pt. I.) Price 25 cents.
- Report on Field Work against Gipsy Moth and Brown-tail Moth.** 1910. (Entomology Bulletin 87.) Price 35 cents.
- Biology of the Termites of the Eastern United States, with preventive and Remedial Measures.** 1915. (Entomology Bulletin 94, pt. II.) Price 20 cents.
- Dispersion of Gipsy Moth.** 1913. (Entomology Bulletin 119.) Price 20 cents.



FARMERS' BULLETIN 1189
UNITED STATES DEPARTMENT OF AGRICULTURE



HANDLING SPINACH FOR LONG-DISTANCE SHIPMENT



SPINACH has become an important winter crop in some of the southern truck-growing sections. Shipments amounting to 2,102 cars were made in 1919, of which approximately 87 per cent were from Texas and Virginia.

Careful handling must begin in the field. The spinach should be handled no more than is absolutely necessary, and each operation should be arranged to cause as little bruising and breaking of the leaves as possible. Slightly wilted spinach plants can be handled with less damage than crisp, turgid ones, but excessive wilting should be avoided.

Washing increases decay. It is recommended that spinach be shipped unwashed, unless it is very dirty. When it must be washed, care should be used.

Prompt and thorough cooling is necessary to secure the best conditions in transit. Crushed ice may be used to advantage in each package, and should be placed in two layers, part in the center and part on top of the spinach. All packages should be loaded right side up in the cars.

To secure the most efficient refrigeration from the ice in the bunkers of cars, space must be provided for air circulation above and below the load.

Contribution from Bureau of Markets

GEORGE LIVINGSTON, Chief

Washington, D. C.

February, 1921

HANDLING SPINACH FOR LONG-DISTANCE SHIPMENT.

V. W. RIDLEY,

Investigator in Marketing Fruits and Vegetables.

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EXTENT OF COMMERCIAL CROP.

SPINACH has been an important winter and spring crop in the Norfolk section of Virginia for a number of years and heavy shipments are made by water and rail to northern markets. Within the last few years this industry has become established in Texas and southern California and has developed so rapidly that shipments from Texas now exceed those from Virginia. In 1919, car-lot shipments from Texas amounted to 954 cars, of which 522 were from the Austin district. The 1919 shipments from Virginia were equivalent to 874 cars. Southern California shipped about 190 cars. Plantings for the 1919-20 season were 6,350 acres in Texas, 3,750 acres in Virginia, and 1,350 acres in southern California. Spinach is also grown to a more limited extent in the New Orleans section of Louisiana, shipments from there being in mixed cars.

In the Louisiana and Texas sections plantings of spinach are made from early fall to midwinter in order to secure plants for harvesting during the months of January, February, March, and April. The most widely grown varieties are the Bloomsdale and Viroflay. The former has a crinkled leaf which is somewhat darker in color than the smooth-leaved Viroflay. Prickly Seeded, another smooth-leaved spinach and the hardiest variety, is grown to a limited extent, but it is discriminated against on the markets on account of its appearance.

METHODS OF HARVESTING.

Spinach may be harvested from the time the plants have five or six leaves until just before the time when they begin to form seed stems. A larger yield, of course, is secured if plants are not cut too early.

The market prefers medium or slightly larger plants, when the leaves are tender and in good condition and the stems are not too coarse. The best time to harvest depends upon market conditions. Two or more cuttings are usually made, the smaller plants being left at the first cutting.

Spinach should be harvested by cutting the tap root just below the lower leaves. A knife with a long blade like a butcher knife is usually used, although a hoe is sometimes employed. The method of harvesting with a knife is shown on the cover, while the use of the hoe for this purpose is illustrated in figure 1. If the tap root is cut short it is possible to avoid taking up a lump of dirt with the plant. Pulling is a practice to be condemned, because it breaks and bruises the tender leaves even when the ground is not hard.

Wages for cutting spinach are often paid at a fixed rate per basket or field box. When whole families, old and young alike, work



FIG. 1.—Harvesting spinach with hand hoes. Laredo, Tex., April, 1919.

in the field, this method has obvious advantages. As a rule more careful cutting is secured if the work is done only by adults.

Some trimming is usually necessary to remove all dead, diseased, or yellow lower leaves, and this can best be done as the plants are cut (fig. 2). These leaves detract greatly from the appearance of the plants and are very susceptible to decay.

It is best not to cut spinach immediately after a rain or a heavy dew, because when the leaves are damp they are crisp and brittle and break easily. When plants are grown under conditions of abundant moisture and cut in damp or cloudy weather it is well to let them lie on the ground one or two minutes, which is long enough to wilt the leaves slightly, before handling. Certain men may cut the spinach and others follow to do the stripping and gather it into the field baskets. Under most conditions plants are not so brittle as to require this preliminary wilting, and when it is permitted there is always danger of too much wilting.



FIG. 2.—Mexicans trimming spinach. Dead leaves and trash should be removed at the time of cutting, to avoid extra handling. Laredo, Tex., April, 1919.

After cutting and trimming, the plants are carried to the packing shed. Hauling in field baskets or boxes is better for the spinach than loading it in bulk, as less handling is involved. The latter method also requires the use of forks in unloading, which results in considerable mechanical damage to the plants, as is shown in figure 3.



FIG. 3.—Unloading spinach from truck at the packing shed. Hauling spinach in bulk causes a great amount of injury to the leaves and leads to decay in transit. Austin, Tex., March, 1919.

Spinach should be removed to the shed and packed as soon as possible after cutting, in order to avoid excessive wilting or heating.

PREPARATION FOR SHIPMENT.

In different sections of the country various packages are used, the round bushel basket, barrel, and lettuce crate being the favorites. In some instances, but not usually, the spinach for each crate is weighed in order to obtain a uniform pack. Facing is sometimes practiced to make the package more attractive.

WASHING.

When spinach is covered with sand or mud from the fields, it is usually washed to improve its appearance. Sometimes it is washed or moistened to restore freshness. It is better to avoid washing when possible, since the washing is likely to bruise the plants and increase decay. In washing, the plants are immersed in water in large tanks of wood, galvanized iron, or concrete, and allowed to remain at least two or three minutes. The plants should be stirred gently in the water to loosen as much dirt as possible. Fresh water should be kept running into the tank, and the wash water should be drained and the tanks cleaned at least once or twice each day. Although it is best to use cold water, it is doubtful whether the addition of ice is advantageous. This washing does not, of course, clean the plants thoroughly; this must be done by the housewife.

ICING.

In addition to the regular icing of the bunkers of the refrigerator car, some crushed ice is used in each package. The amount of crushed ice for each package varies somewhat under different conditions, the quantity ordinarily provided being from two-thirds to three-fourths of the weight of the spinach. In icing barrels, the ice is usually distributed in three or four layers. Some ice should be placed on top next to the barrel head to keep the spinach in the upper part of the barrel fresh. More ice should be used in the layer next to the top of the barrel than in the other layers and holes should be bored in the bottoms of the barrels to insure drainage.

Baskets are usually iced with one shovelful near the center of the basket, but the more desirable method is to place about half the ice in the center and the remainder on top.

LOADING CARS FOR SHIPMENT.

For shipments which may be in transit several days the use of floor racks is desirable. This provides open spaces under the load for air circulation from the ice bunkers of the cars, thus facilitating

thorough refrigeration throughout the car from the ice in the bunker. Otherwise this refrigeration is applied largely to the packages next to the bunkers, and does not reach those out toward the center of the car, which is usually the warmest part of the load. For the same

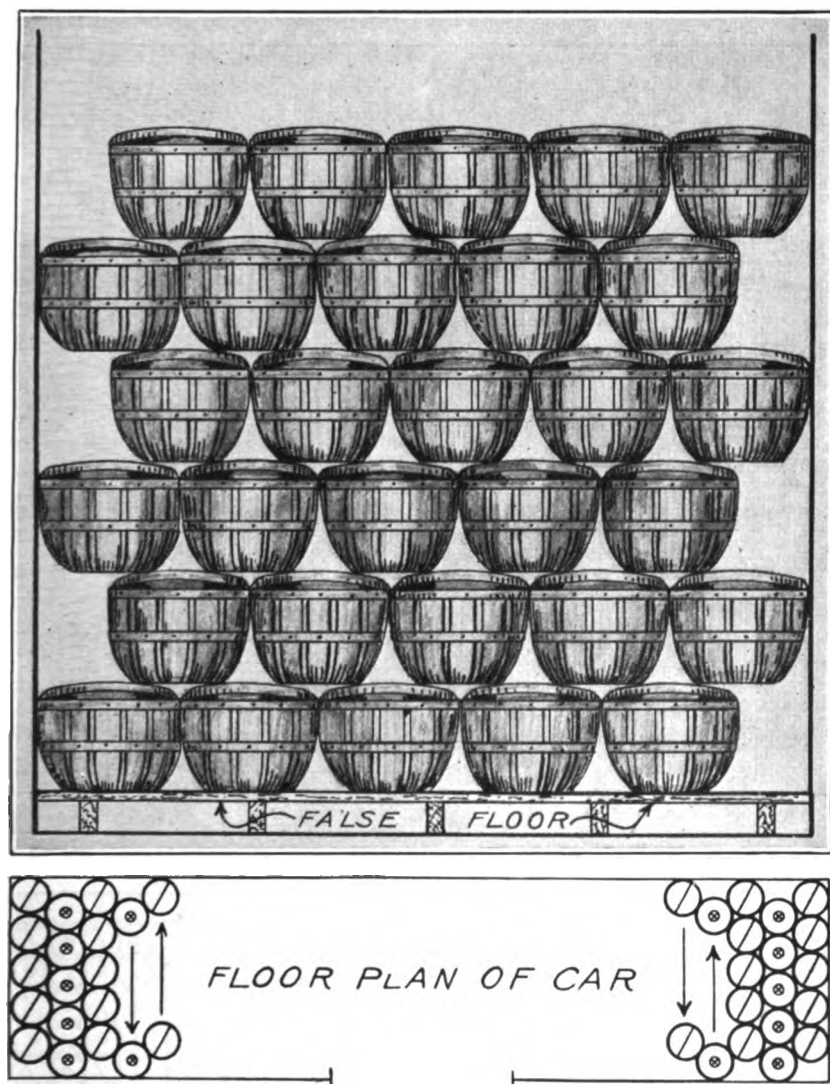


FIG. 4.—Method of loading bushel baskets. Alternate baskets reversed.

reason, also, it is unwise to block the air circulation back to the ice bunkers by loading close to the ceiling of the car. Figures 4 and 5 show cars of baskets loaded properly to provide for air circulation both above and below the load.

PREVENTION OF DETERIORATION IN TRANSIT.

The shipments from Virginia, because the haul is comparatively short, usually reach the market in sound condition without refrigeration. However, when shipments were begun from Texas and other

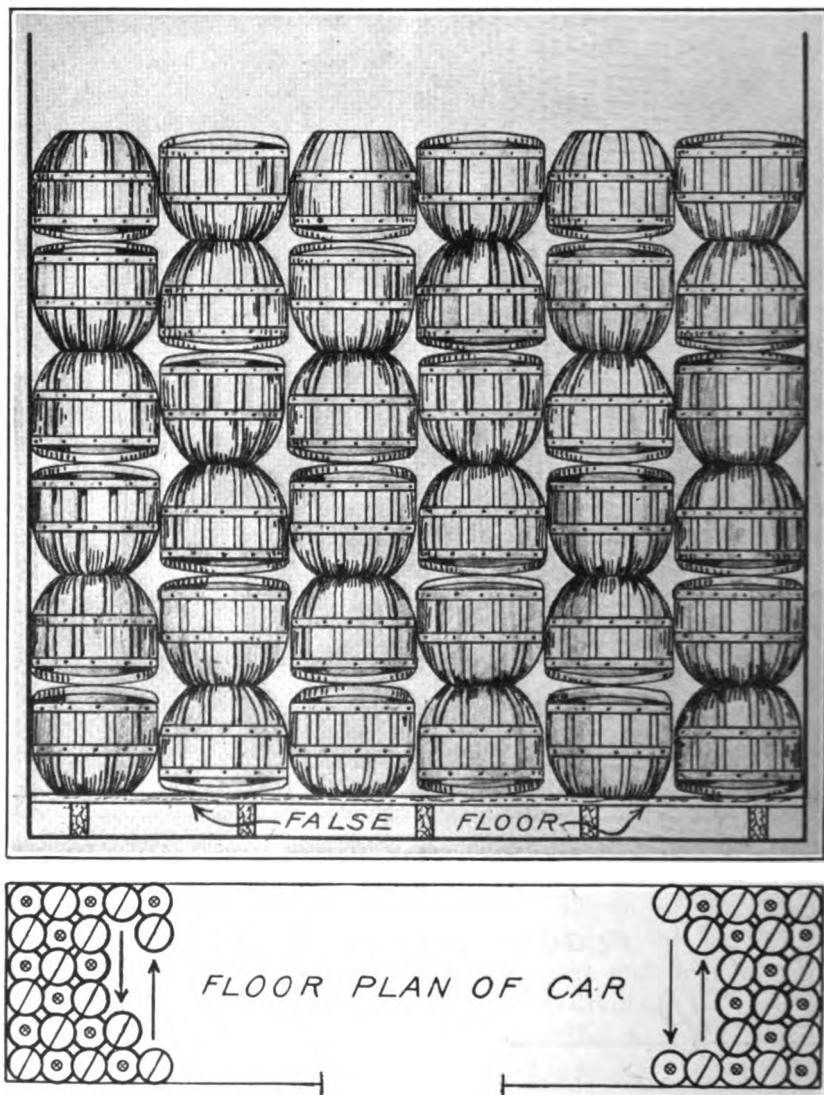


FIG. 5.—Baskets loaded in straight rows.

distant points, where the haul is from one to two thousand miles instead of a few hundred, new conditions were encountered and heavy losses from decay in transit were frequently experienced. These shipments were all in express or freight refrigerator cars, and extra

crushed ice was usually added in each package to prevent wilting. The causes for this deterioration and decay in transit were not understood, and considerable difference of opinion existed among shippers, carriers, and receivers as to the best methods of handling spinach for long hauls.

With these facts in mind, and at the request of various shippers and transportation agents, a study was undertaken by the Bureau of Markets in 1918 to determine the factors involved in the safe transportation of spinach and other winter-vegetable crops. The work was carried on in the New Orleans section of Louisiana and at Austin and other points in Texas during the shipping seasons of 1918 and 1919. The pathological problems involved were studied by the Bureau of Plant Industry.¹

The only decay of importance occurring on spinach in transit is soft rot, a slimy bacterial decay, which is also prevalent on the tops and roots of various other crops in transit and storage. Soft rot develops with exceeding rapidity when temperature and moisture conditions are favorable. It first produces a water-soaked appearance, followed by complete disintegration of the affected tissue, and is often accompanied by a more or less unpleasant odor. In the advanced stages of the rot spinach shrinks in volume and becomes "leaky," often staining the crates with green juice from the destroyed tissue. Soft rot, if well started in transit, is capable, under favorable conditions, of rendering spinach entirely worthless within two or three days after removal from the cars.

Soft rot of spinach is caused by bacteria² which gain entrance at points where the tissue has been bruised or wounded in some way. An example of soft rot starting around the tie band of a bunch of spinach where the leaves and stems have been bruised is shown in figure 6. In order to reduce losses from this decay it is necessary to avoid mechanical injuries to the plants in handling. Soft rot also starts readily on the lower leaves, which are in a state of "physiological old age," and upon leaf spots resulting from fungus attacks originating in the field, such as those caused by mildew³ and anthracnose.⁴

A number of tests made to determine the relation of mechanical injuries to decay showed in every instance that less decay was found in carefully-handled lots, the average being only about one-half that which occurred in comparable lots receiving ordinary commercial handling.

¹ Acknowledgment is made of the valuable work of Dr. J. C. Walker, of that bureau, in identifying the decaying organisms and for other pathological work.

² These bacteria may consist of one of many species belonging to a group of which *Bacillus carotororus*, Jones, is a typical example.

³ *Peronospora effusa*, (Grev.) Rbh.

⁴ *Colletotrichum spinaceae*, Ell. & Halst.

A number of holding and shipping tests were made to determine the influence of washing on the keeping qualities of spinach. The holding tests were conducted in Louisiana during the first season of this investigational work. The experimental lots were packed and held for 10 days under approximate transit conditions on the basis of shipments by freight to northern markets. Those lots which were washed developed an average of 37.3 per cent soft rot, while those that were unwashed developed only 7.7 per cent.

The shipping tests were included in regular car-lot shipments during the second season of the investigational work. These shipments were almost entirely by express, the transit period to Chicago and New York lasting from three to six days. Inspections made at

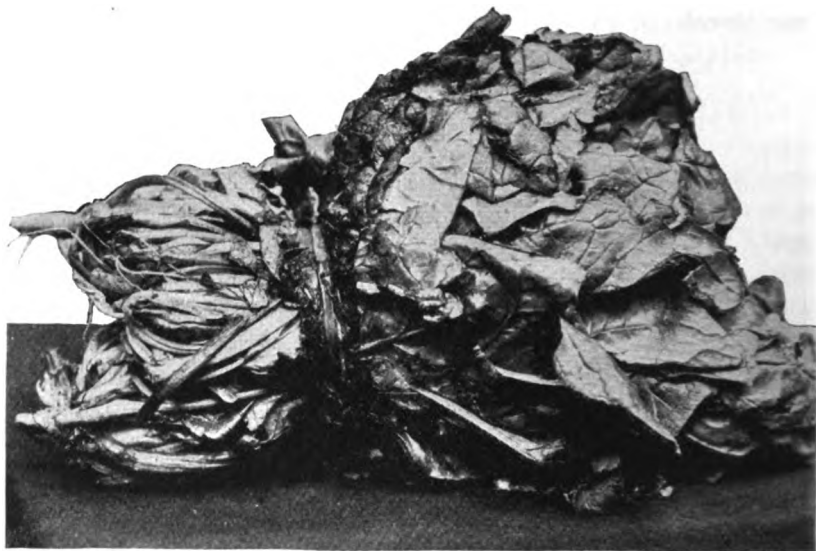


FIG. 6.—Soft rot starting in bunched spinach where leaves have been bruised by the tie band. The practice of bunching spinach is not recommended.

destination showed that the average percentage of soft rot found in washed spinach on arrival was 5.5, and in unwashed spinach 0.0; three days later the washed spinach showed 24.8 per cent decay and the unwashed 5.7 per cent. The differences in the amounts of decay shown in the lots held and in the lots shipped are due to the differences in the length of periods involved.

These tests show conclusively that, other conditions being equal, washed spinach will decay more quickly than unwashed spinach. The amount of decay that develops depends, of course, to a considerable extent upon the length of time the spinach is in transit. Some of these lots were in transit only three days. The most striking differences between the washed and unwashed lots appeared in cars that were in transit six days and longer.

The advantage gained by shipping unwashed spinach was offset to some extent by increased yellowing and wilting in the spinach above the ice in the unwashed baskets. When part of the ice was put above the spinach on top of the baskets, as described on page 6, this difficulty was entirely overcome and the unwashed lots arrived in excellent condition.

The increase in decay arising from washing spinach is caused in part by the extra handling. Mechanical injuries occur very easily in handling spinach after washing, as the water makes the leaves crisp and brittle. In addition, the excess moisture from washing is favorable to the development of decay, and increased infection doubtless results from the repeated use of the same water when decay organisms are present.

EFFECT OF ICE IN THE PACKAGE ON DECAY.

Holding and shipping tests were made both with and without ice in the package, and much better results were obtained when ice was used, the lots in each separate test being strictly comparable in every other respect. The average percentages of soft rot found in tests in which the packed spinach was held 10 days under conditions approximating those encountered in transit were 31.7 when crushed ice was in package and 55.5 when no ice was in package. Shipping tests by express to New York and Chicago showed that ice in the package reduced the decay greatly. The average percentages of soft rot found in comparable lots after arrival at destination were: Crushed ice in package, 0.0; and no ice in package, 8.9. Three days later the rot in iced packages was 11.9 and the rot in packages without ice 26.8.

Deterioration in transit results from yellowing and wilting as well as from decay. Yellowing occurs when the temperatures in transit become too high.

Several shipping tests were made in which half of the ice was placed in the center of the basket and the remainder on top of the spinach just under the basket cover. This method gave much more satisfactory results than that of placing all the ice in the center of the basket. Unwashed spinach shipped in this manner arrived crisp and fresh on top as well as all through the basket, even when it had been somewhat wilted at the time of packing. When the ice was divided into two layers, it was found that there was more meltage and less ice left at destination, and consequently more refrigeration in transit. In loading cars with baskets iced in this manner, it is necessary to place all the baskets right side up in order to secure the full benefit of the top layer of ice.

Observers accompanied one test trip of two express refrigerator cars from Austin, Tex., to Chicago, Ill. The cars were similar

in construction with bunkers of an open type, and 2-inch floor strips in place of floor racks. One car contained 813 baskets of spinach loaded five high and six wide; the other contained 1,050 baskets loaded six high and six wide, this latter car being loaded to within about 7 inches of the ceiling. One layer of crushed ice, about 14 pounds, was placed in the center of each basket in both cars. By means of electric thermometer equipment, temperatures of the spinach

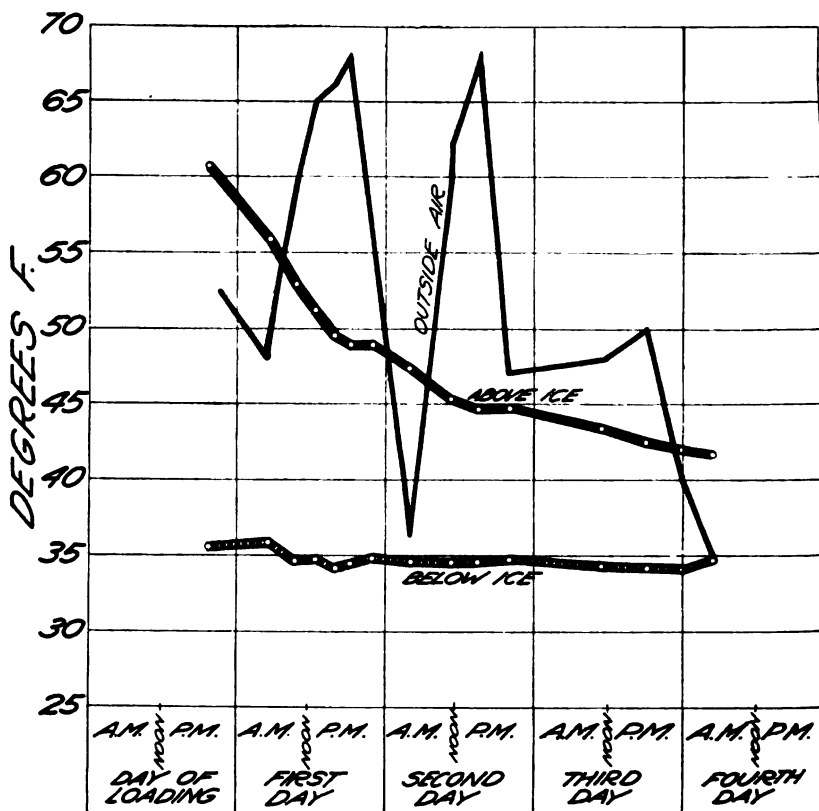


FIG. 7.—Diagram showing the average spinach temperature above and below the ice in the same baskets in the top layers midway between the doors and ice bunker in two express refrigerator cars from the time they were loaded at Austin, Tex., until they were unloaded at Chicago, Ill., March, 1919. All of the baskets in these shipments were iced with about 14 pounds of crushed ice placed near the center of the package. These averages show the need for better distribution of the crushed ice.

at several points inside these cars were determined at frequent intervals during the trip without opening the cars.

Figure 7 illustrates graphically the average temperatures of the spinach in baskets in the top layers of two cars, halfway from the forward bunker to the doorway, both above and below the layer of ice. It is shown that the temperature of the spinach below the ice was uniformly between 34° and 35° for the entire trip, while

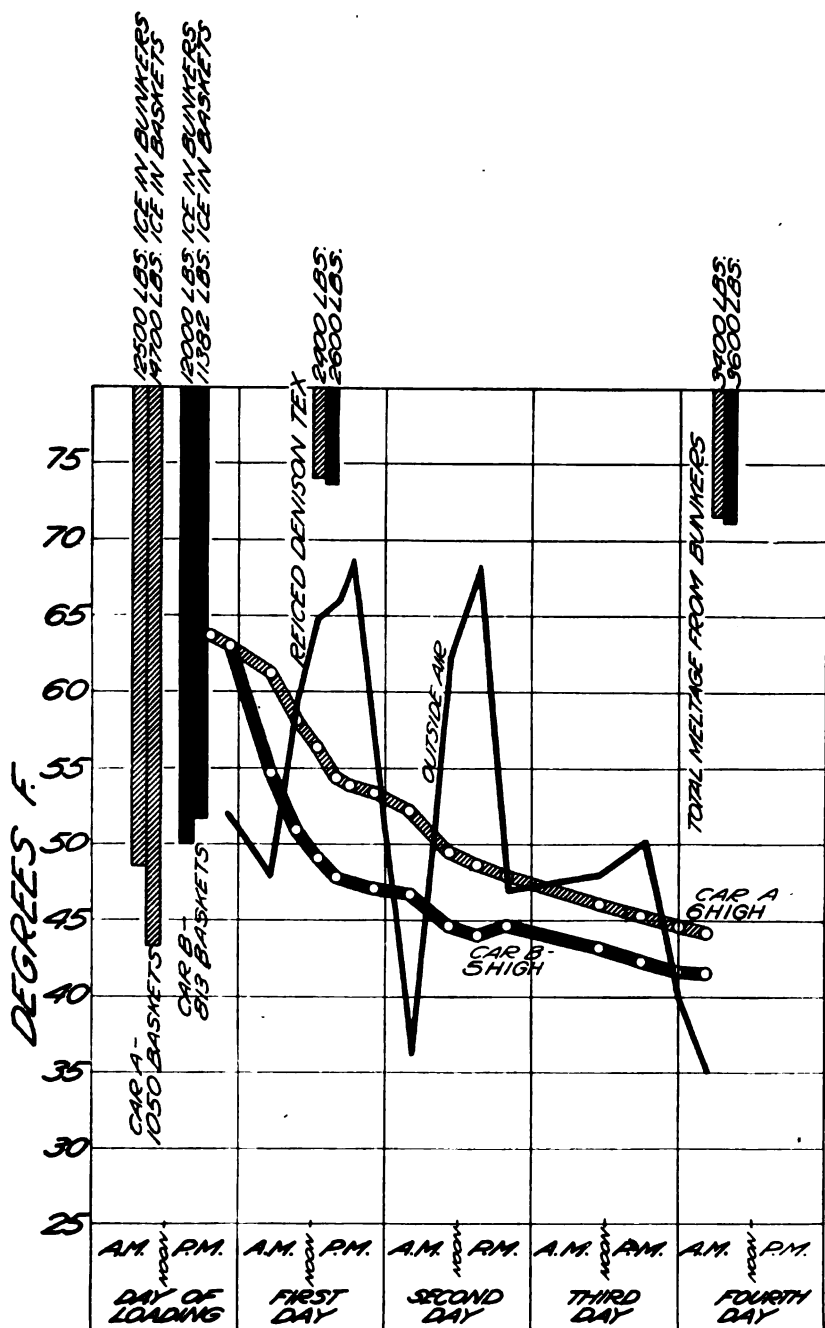


FIG. 8.—Diagram showing the temperatures of the spinach above the ice in the baskets in the top layer, in two express refrigerator cars, in transit from Austin, Tex., to Chicago, Ill., March, 1919, one car being loaded six high and the other five high.

above the ice the temperature of the spinach was about 61° when the cars were loaded, and it was not reduced below 42° during the entire trip. These temperatures are largely equalized when part of the ice is placed at the top of the basket.

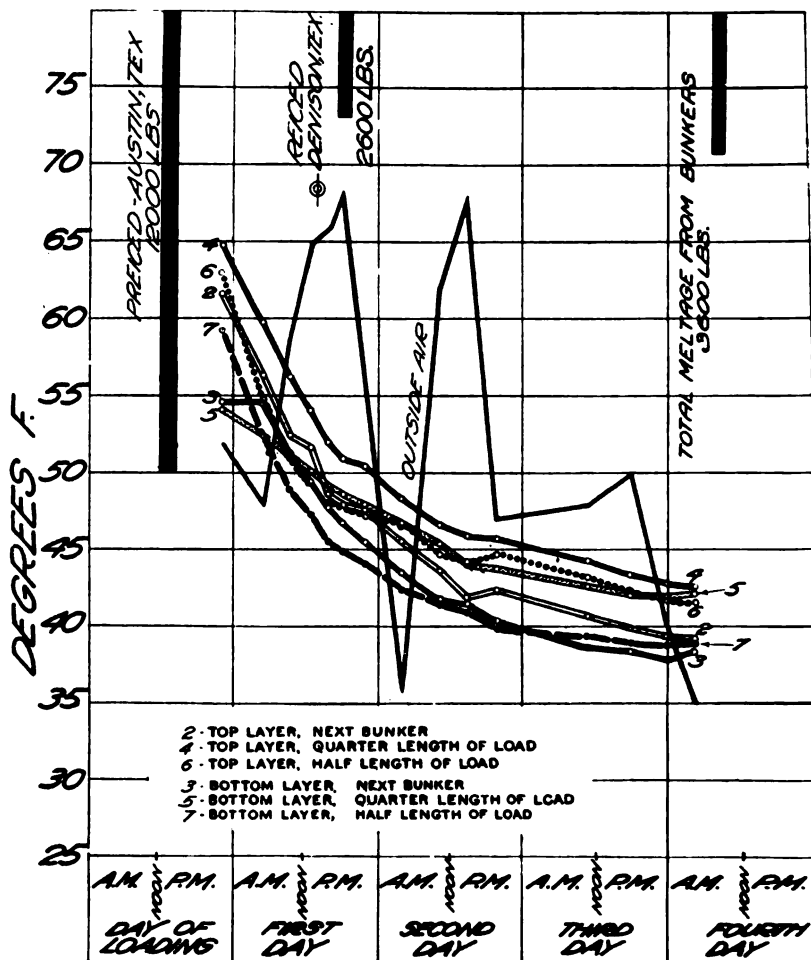
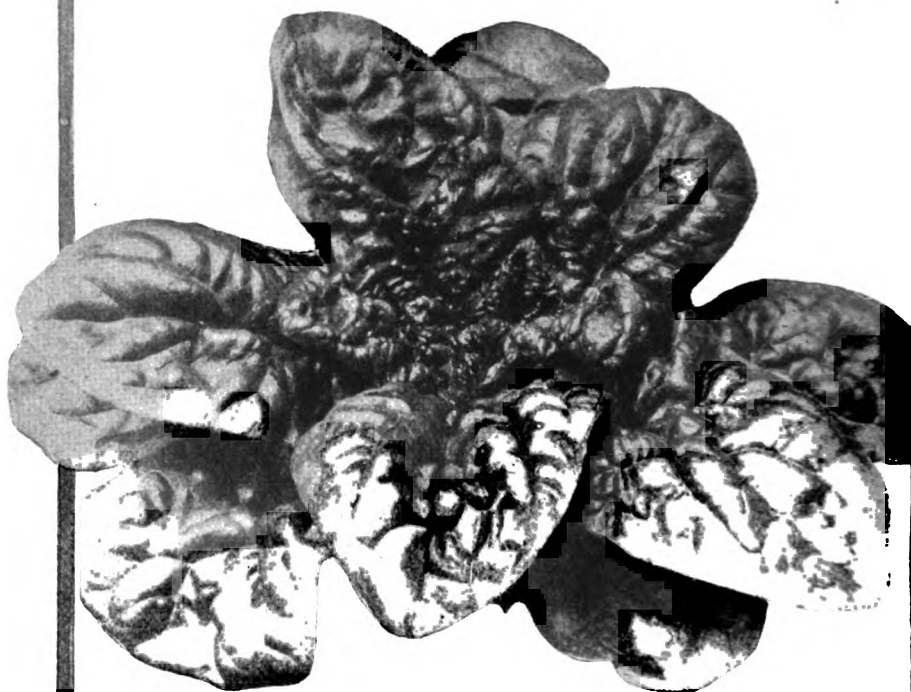


FIG. 9.—Diagram showing actual spinach temperatures in six different parts of an express refrigerator car from the time it was loaded at Austin, Tex., until it was unloaded at Chicago, Ill., March, 1919. The car contained 813 round bushel baskets of spinach, each one containing about 14 pounds of crushed ice in the center of the basket. All temperatures shown were taken in the part of the basket above this layer of ice. The car had 2-inch floor strips in place of floor racks, bunkers of an open type, was loaded solid at the doorway and to within 18 inches of the roof, the baskets being stacked 5 high.

Loading tests included use of floor racks and also the number of baskets and arrangement most advantageous for a load. A comparison of the temperature conditions in the top layers of cars loaded five and six baskets high is presented in figure 8, the data

being secured on the test trip mentioned above. Each basket contained about 14 pounds of crushed ice in a single layer at the center of the basket. This diagram shows the temperatures of the spinach above the layer of ice in baskets midway between the car doors. In the car loaded five high the top layer was cooled 15° in the first 20 hours, while in the car loaded six high the top layer was reduced only 9° in the same length of time. The difference in the temperatures in this position in the two cars for the rest of the trip was 3° to 5° in favor of the five-high load.

The temperatures of the spinach in six different locations in the car loaded five high are illustrated in figure 9. Rapid refrigeration of the spinach occurred throughout the car during the first day of the trip. The top layer cooled at about the same rate as the bottom but held higher temperatures throughout the trip. The temperature of the whole load was uniform when it was loaded, but the first temperatures shown were taken several hours after the car had been closed. The melting ice should cool the leaves sufficiently to keep them fresh and in good condition if the ice is distributed and some of it is placed on top of the spinach just under the basket cover.



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FARMERS' BULLETIN 1190

UNITED STATES DEPARTMENT OF AGRICULTURE

HOW TO GROW AN ACRE OF POTATOES



TO GROW A GOOD CROP OF POTATOES

Select a soil that works easily, that is well supplied with humus, and is not subject to drought.

Apply plant food liberally.

Plow as deep as possible, 8 or 10 inches if the surface soil will permit.

Conserve soil moisture by disking fall-plowed land in early spring and the spring-plowed land as soon as plowed.

Put the soil in the best possible shape before planting.

Plant a variety adapted to your locality and soil.

Use the best seed obtainable.

Disinfect the seed potatoes before cutting them.

Cut blocky seed pieces, weighing from 1 to 2 ounces.

After planting keep the surface of the ground loose and friable until the plants appear.

After the plants appear give deep cultivation. Cultivate often enough to keep the soil loose and the weeds destroyed.

Prevent injury to the plants from disease or insect pests by spraying them with suitable fungicides and insecticides.

If you live where it is possible to produce good seed, improve your stock by systematic selection of tubers from the best-producing plants. This should be done in the field, by hand-digging a goodly number of promising-looking plants.

Increase your returns from the crop by carefully grading it.

Contribution from the Bureau of Plant Industry

WM. A. TAYLOR, Chief

Washington, D. C.

March, 1921

HOW TO GROW AN ACRE OF POTATOES.

PREPARED ESPECIALLY FOR USE IN BOYS' AND GIRLS' CLUB WORK.

WILLIAM STUART,

Horticulturist, Office of Horticultural and Pomological Investigations.

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FOREWORD.

THE REMARKABLE SUCCESS which has attended the efforts of those who have been instrumental in organizing and directing boys' and girls' club work in this country is a splendid tribute to the leaders in this movement and proof of the hearty cooperation which they have received from those boys and girls whom they have enlisted in the work. When a boy or a girl succeeds in raising a plat of potatoes yielding at the rate of 300 to 600 or more bushels per acre, as many of them have done, it is a source of inspiration to those of their club who have been less fortunate, and, what is perhaps of greater importance, an object lesson to their elders as to what can be accomplished when the crop is given proper cultural attention.

If all boy and girl club members were able to produce as large crops of potatoes as have been mentioned, there would be little necessity for suggestions on "How to grow an acre of potatoes." It is assumed, however, that many members of these clubs have at one time or another found themselves face to face with problems which they were only partially able to solve. A poor stand of plants, the

presence of certain insect pests or of fungous diseases attacking different parts of the plant, or poor yields from promising-looking plants may have served to dampen the youthful ardor of some members. The aim of this bulletin is to aid those who may have been confronted with these or other difficulties to meet and overcome them more successfully, to the end that their efforts may be crowned with a well-deserved success.

INCREASED POTATO PRODUCTION DESIRABLE.

The average production of potatoes in the United States for the past 10 years, 1910 to 1919, inclusive, was 96.8 bushels per acre. During the same period the State of Maine produced an average of 201 bushels per acre, or 107 per cent more than the average of the entire United States. When it is remembered that commercial yields of 500 to 600 bushels per acre are by no means uncommon in this country and that on small areas (an acre or less) much larger yields have been obtained by boys and girls belonging to agricultural clubs, one can readily see that there is plenty of opportunity for increasing the per-acre production of potatoes in the United States.

Heretofore potato production in this country has been conducted along extensive rather than intensive lines. In other words, we have been satisfied to plant twice as many acres as should have been necessary to produce a sufficient quantity of potatoes for our food requirements. Present economic conditions compel the grower to consider more seriously the desirability of reducing the cost of production by increasing the yield per acre. Increased production per acre at a reduced cost per bushel should be the goal of every potato grower in this country. The successful accomplishment of this result is dependent upon many factors, the chief of which are (1) the selection of a suitable soil, (2) the proper preparation of the soil, (3) the selection of the right varieties for the locality in which they are to be grown, (4) the planting of high-grade seed stock, (5) an abundant supply of plant food, (6) good tillage, and (7) thorough protection of the plants against fungous diseases, insects, and other pests.

SELECTION OF SUITABLE SOIL.

While the potato is probably as easily satisfied in its soil requirements as any other food plant, it thrives better on some soils than on others. Gravelly or sandy loam soils are generally considered especially well suited to the production of large crops of potatoes, provided they are well drained and well supplied with plant food. A very light sandy soil or a stiff clay soil should be avoided when selecting land for potatoes if large yields are desired. The ideal soil is one that does not run together in heavy rains, that works easily, that

is well supplied with humus (decaying vegetable matter), and that while well drained is naturally supplied with sufficient moisture to keep the plants in a thrifty growing condition. Clover or alfalfa is generally regarded as the best preparatory crop for potato land. Either of these crops furnishes a goodly supply of humus when turned under and materially increases the moisture-holding capacity of the soil.

The economical production of an acre of potatoes is dependent to a certain extent upon its shape. For example, the longer the rows are the more economically they can be planted, cultivated, and sprayed, because long rows entail less turning and therefore less lost motion. Sixteen rows 3 feet apart and 907½ feet long represent 1 acre and are of a suitable length to till.

PREPARATION OF THE SOIL.

The land should be plowed as deeply as the character of the surface soil will permit. If the surface soil is 10 inches deep, plow it to that depth or a little more. If it is only 6 inches deep, plow 6½ to 7 inches deep. The aim should be to plow from one-half to 1 inch deeper than formerly, in order to increase the depth gradually and thereby augment the water-holding capacity of the soil.

Generally speaking, land that is intended for potatoes should be plowed preferably in the autumn. There are exceptions, however, to such a practice, as in the case of land that is likely to wash badly from winter rains or melting snows, or on which the crop is not to be planted until rather late in the season. In the last case it may be possible to turn under a considerable growth of clover or alfalfa by delaying the plowing until shortly before the planting season.

If plowed in the fall, it should be disked or harrowed as early in the spring as possible, in order to conserve the moisture accumulated during the winter or early spring and to prevent weed growth. The object should be to maintain a surface mulch of loose soil after each beating rain. When plowed in the spring, disk it immediately, in order to prevent the possible baking of the newly turned soil and to conserve the moisture.

In preparing the seed bed, spare no pains to fine the soil and to put it in as friable a condition as possible. To do this may require the use of a cutaway or disk harrow, a spring-tooth harrow, and a smoothing harrow, followed with a plank drag if the surface is slightly uneven or lumpy. Thoroughness in the preparation of the seed bed is as essential to the successful production of a large crop of potatoes as in any other step in the process. In fact, if the crop is planted on land that is poorly prepared, no amount of subsequent cultivation will entirely remedy the defect.

SELECTION OF THE RIGHT VARIETY.

Select a variety that is known to be adapted to your section and that meets the requirements of the market in which it is to be sold. If you are in doubt as to the best variety to grow, consult your county agent. The following list includes what may be considered the leading commercial varieties grown in the United States at the present time:

Early-maturing varieties.—Irish Cobbler (fig. 1), Triumph (fig. 2), Early Ohio, Spaulding No. 4 (*Rose No. 4*).

Medium or late maturing varieties.—Burbank, Russet Burbank, Green Mountain, Rural, Russet Rural, Pearl, McCormick, White McCormick, Perfect Peach-blow (*Red McClure*), Charles Downing (*Idaho Rural*), Brown Beauty.

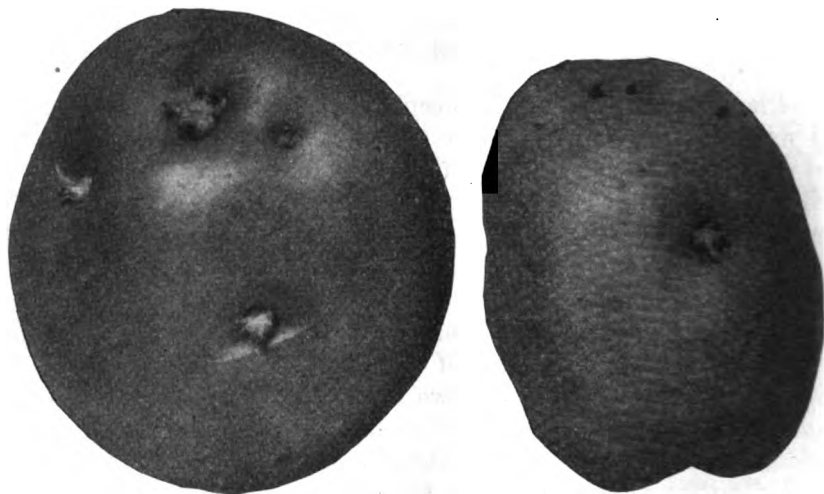


FIG. 1.—Upper and side views of a fair type of Irish Cobbler seed potato.

The Irish Cobbler is grown extensively as an early truck crop in the Atlantic Coast States north of Florida, in the Louisville, Ky., district, and to some extent in the Kaw Valley in Kansas. It is principally grown for seed purposes in northern Maine, Vermont, and New York; also to some extent in Michigan, Wisconsin, Minnesota, and North Dakota; in fact, it is grown more or less in practically every State in the Union.

The Triumph is extensively grown as an early truck crop in southern Florida, Alabama, Mississippi, Louisiana, Texas, Oklahoma, and Tennessee. For seed purposes it is grown in the northern part of Maine, Wisconsin, Minnesota, North Dakota, and northwestern Nebraska. It thrives best in a cool moist climate.

The Early Ohio is most largely grown for table purposes along the Ohio River in West Virginia, in Ohio, Illinois, Missouri, Wisconsin, Minnesota, North Dakota, South Dakota, Nebraska, Kansas, and

Colorado. The seed-production centers are in the Red River Valley in Minnesota and North Dakota, and to some extent in northern Wisconsin and Maine. The Early Ohio is also grown to a lesser extent in other sections.

Spaulding No. 4 is grown almost exclusively as a truck crop in the central and northern portions of Florida, and for seed purposes in Aroostook County, Me. A variety known as King is so nearly like Spaulding No. 4, if not identical with it, that it is frequently substituted for it. This variety is grown to a considerable extent in northern Wisconsin and Minnesota, and to a less extent in north-western Nebraska. The King variety seems to be especially well adapted to light soils.

The Burbank and Russet Burbank are grown most extensively in Colorado and States west to the Pacific coast. The Russet Burbank



FIG. 2.—Extra-fine specimens of Wisconsin grown Triumph seed potatoes.

is grown to some extent for seed purposes in the north-central portion of Minnesota.

The varieties belonging to the Green Mountain group, which includes the Green Mountain, Gold Coin, Norcross, and Delaware, are grown most extensively in the New England States, northern New York, on Long Island, in New Jersey, northwestern Maryland Pennsylvania, northern Wisconsin and Minnesota, and to a less extent in the mountainous sections of Virginia, West Virginia, North Carolina, and South Carolina. These varieties are especially sensitive to heat and drought, and should be planted only where the summer temperature is relatively low and the rainfall ample. They are heavy yielders and the tubers are of high table quality.

The Rural and Russet Rural varieties represent a strong, vigorous-growing race of potatoes embodying such varieties as the Rural New Yorker No. 2, Sir Walter Raleigh, Carman No. 3, and numerous others. They are grown most extensively in western New York,

Pennsylvania, Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, and Colorado. The Russet Rural is an especial favorite in Michigan and is gaining favor in New York and Pennsylvania. It is grown to some extent as a fall crop in mountainous sections of the South.

The Pearl variety is grown most extensively for table purposes in Colorado, particularly in the Greeley district, and for seed purposes in central Wisconsin, where it is commonly known under the name of Peerless.

The McCormick variety is exclusively grown in the South as a fall crop. It is most largely grown in Maryland, Virginia, North Carolina, South Carolina, Tennessee, and Georgia. In the latter States it is known under the names of Lookout Mountain and Hoosier. It is especially resistant to heat and drought and is the surest late-crop variety that can be grown in the South. Unfortunately it is a deep-eyed, low-quality potato.

The White McCormick is a white-skinned variety having the same resistant qualities as the McCormick, but it is not so deep eyed and is of better table quality. It is grown in the same localities.

The Perfect Peachblow (*Red McClure*) is perhaps the least extensively grown of all the varieties listed, being practically restricted to the Carbondale and Eagle districts in Colorado. When well grown it is a handsome and prolific variety, but it has a very limited range of adaptability.

The Charles Downing (*Idaho Rural*) potato is grown most extensively in southern Idaho, in which region it is commonly spoken of as the Rural or Idaho Rural. In Colorado it is usually called the Charles Downing, though in some localities where recently introduced it is called Idaho Rural. It was observed growing in northwestern Nebraska in 1919. The variety sets a heavy crop of tubers and must have a good supply of moisture and plant food if a large percentage of the tubers is to reach marketable size. It is best adapted to the irrigated regions of the West.

Brown Beauty is a variety that has become very popular in the San Luis Valley in Colorado. It is a heavy producer of tubers of medium size.

HIGH-GRADE SEED STOCK.

High-grade seed stock may be defined as seed that is true to name, produced by strong, healthy plants that have developed a goodly number of tubers of even, marketable size and uniform shape, and that are partially unripe when harvested.

The boy or girl who fails to recognize the necessity of using good seed can not hope to produce a very large crop. Recent studies have shown that there is a very considerable variation in the productive

capacity of different strains of supposedly high-grade seed of the same commercial variety. These studies, which were undertaken in 1919 by the United States Department of Agriculture in cooperation with the Wisconsin Agricultural Experiment Station at their Spooner branch station, showed a variation in the yield of nine strains of Triumph potatoes ranging from 116 to almost 223 bushels of marketable tubers per acre, or a difference in yield of 107 bushels between the lowest and the highest producing strains. These results are not at all unusual, as may be judged from some tests made at an earlier date by the Canadian Department of Agriculture on their experimental farm at Kentville, Nova Scotia, where some 15 strains of the Garnet Chili potato secured from as many different growers in various parts of Nova Scotia, New Brunswick, and Prince Edward Island were tested as to their productiveness. The yields ranged from 55 $\frac{3}{10}$ to 236 bushels of marketable potatoes, or a variation of nearly 181 bushels per acre. Many other similar examples might be cited, but these should serve to convince us that there may be just as great variations in the productive capacity of different strains of potatoes, due largely, we believe, to the presence of heritable diseases in the seed stock, as between the milk and butter yielding capacities of individual milk cows of the same breed. For more detailed information, consult Farmers' Bulletin 533, entitled "Good Seed Potatoes and How to Produce Them," and Circular No. 5 of the Office of Cotton, Truck, and Forage Crop Disease Investigations, entitled "Growing High-Grade Potato Seed Stock."

PLANT FOOD SUPPLY.

A maximum crop of potatoes can be produced only when the soil in which they are grown is well supplied with available plant food. If a good clover, alfalfa, cowpea, soy bean, or other leguminous crop has been turned under, a much smaller application of commercial fertilizers or barnyard manures will be necessary than if the preceding crop was a grain crop. In the early truck-crop sections of the South many of the growers apply a ton or more of a 7-6-5 fertilizer¹ to the acre. The southern truck grower tries to start his early crop as quickly as possible by using a large amount of nitrogen (usually called ammonia) to stimulate stem and leaf growth, thereby securing a strong, vigorous plant. As a rule, fertilizer applications in the South vary from 1,500 to 2,500 pounds per acre. The New

¹ The common way of stating the chemical analysis of a commercial fertilizer is to give the percentage of nitrogen first, then the phosphoric acid, and lastly the potash. Thus, a 7-6-5 fertilizer means 7 per cent of nitrogen, 6 per cent of phosphoric acid, and 5 per cent of potash.

Jersey, Long Island, and Maine potato growers use quantities equally as large as the southern growers, but with slightly different percentages of nitrogen, phosphoric acid, and potash.

FERTILIZER ANALYSES.

The following standardized fertilizer analyses are recommended for three types of soil—sandy, loam, and clay—in the southeastern, eastern, and western sections of the United States:

TABLE I.—*Standard fertilizer mixtures, showing the proportion of nitrogen, phosphoric acid, and potash recommended for three types of soil.*¹

Soil.	Southeastern States.		Eastern States.	Western States.
	Early crop.	Second, or winter, crop.	Late crop.	Late crop.
Sandy.....	7-6-5	2-10-6	5-8-7	3-10-4
Loam.....	5-8-5	2-10-6	4-8-6	3-10-7
Clay.....	4-8-4		4-8-4	3-12-0

An intelligent choice of a commercial fertilizer must take into consideration the previous treatment of the land and its present fertility. In fields where previous crops of potatoes have shown a tendency to scab, barnyard manure is likely to increase this disease and in such cases should be used sparingly and applied to the crop of the preceding year rather than directly to the potato crop. In the eastern and southeastern sections of the United States it is more economical, as well as more desirable, to supplement barnyard manures with a light application of a low-grade commercial fertilizer analyzing approximately 2 per cent of nitrogen, 12 per cent of phosphoric acid, and 2 per cent of potash. If the land is known to be well supplied with potash, a 2-12-0 fertilizer¹ will serve the purpose. The nitrogen of the fertilizer should be derived from nitrate of soda or sulphate of ammonia, which provides this plant food in an immediately available form and helps to start the plants off quickly. The high content of phosphoric acid supplies the deficiency of that element in the manure, and the 2 per cent of potash furnishes an addition of this ingredient welcome to the potato crop. When the two sources of plant food are used, an application of 10 to 12 tons of farm manure and 600 pounds of a 2-12-2 fertilizer may be depended upon to produce satisfactory results. In the West, where the soils are as a rule abundantly supplied with phosphorus and potash but are deficient in nitrogen and humus, barnyard manures supply the elements necessary to the satisfactory growth of the potato plant.

¹ See the footnote on p. 2.

MANNER OF APPLICATION.

It is usually preferable to apply the manure to fall-plowed land in the late winter or spring and disk it in or to spring-plowed land before plowing. Commercial fertilizers are generally applied in the drill row and well worked into the soil before dropping the seed.

When machine planters having a fertilizer-distributing attachment are used the fertilizer is distributed and the seed planted at a single operation.

SEED DISINFECTION.

The disinfection of seed potatoes was primarily undertaken for the prevention of potato scab, but it has since been found that when properly done it is also effective in destroying the resting stage of the black-scurf fungus.² The disinfection of seed potatoes to free them from potato scab and black scurf is recommended as a general

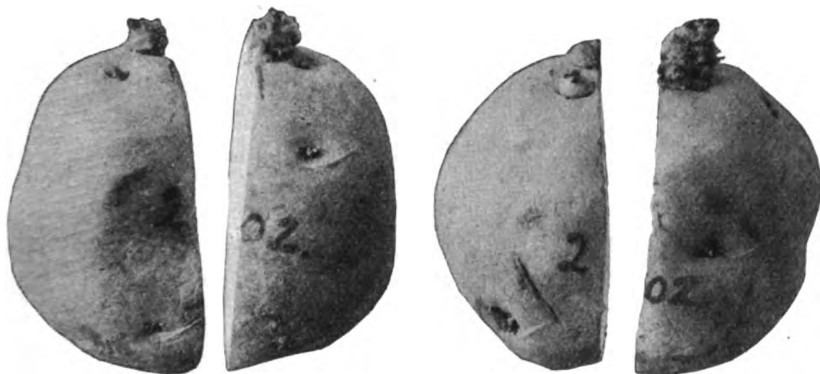


FIG. 3.—Two 2-ounce Irish 'Cobbler' potato tubers cut in two.

practice, though it will not prevent either the scab or the black scurf when it is present in the soil and the conditions are favorable for its growth. The seed should be treated before it is cut. The treatment consists in immersing the tubers for a period of one to two hours in a corrosive-sublimate or formalin solution. The corrosive-sublimate solution is more effective in destroying black scurf than is the formalin and should be employed in treating seed stock infected with this disease. The solutions are made as follows:

Corrosive-sublimate solution.—Dissolve 4 ounces of corrosive sublimate in 2 gallons of hot water; then add 28 gallons of water. Soak the seed tubers from half an hour to two hours. The length of treatment should be varied according to the condition of the seed stock. If it is firm and has not germinated and has any considerable amount of black scurf on it, give the longer treatment. On the other hand, if it is much germinated or is free from black scurf give the shorter period of treatment.

² Known as *Rhizoctonia solani*.

Formalin solution.—Use 1 pint of formalin to 30 gallons of water. Vary the period of treatment, as advised above.

Corrosive sublimate is an extremely poisonous substance, and every precaution should be taken to prevent farm animals from drinking the solution. Care should be exercised in the use of the vessels

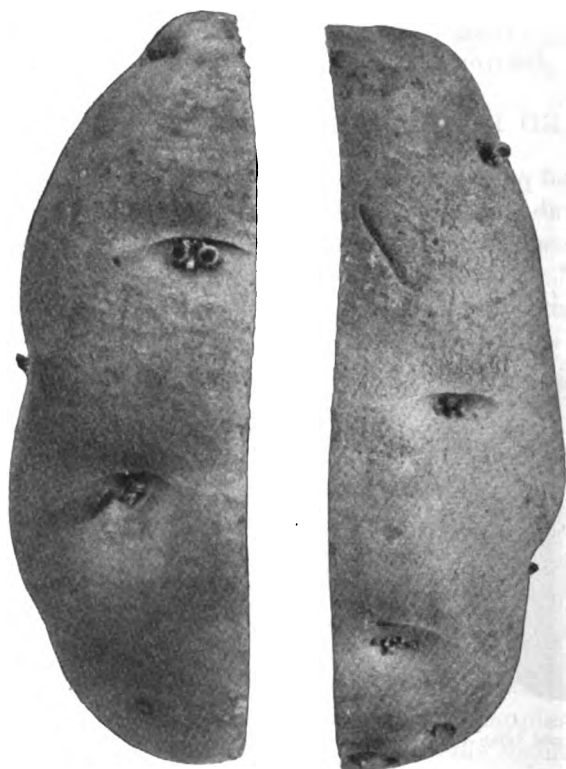


FIG. 4.—First step in cutting a potato tuber into seed pieces or sets.

afterwards to see that they are thoroughly rinsed out. Being a metallic substance which readily attacks metals, only wooden, earthen, or concrete vessels can be used safely. Owing to the fact that a considerable quantity of the corrosive sublimate is absorbed by the tubers and the containers in which they are placed, the strength of the corrosive sublimate is quite materially reduced with each treatment; hence it is necessary to renew the solution after three or four lots have been treated in it. This makes it a little more troublesome

and expensive than the formalin treatment, for the strength of the latter is not diminished. Seed potatoes, to be effectively treated, should be as free from dirt as possible. The newly treated seed should be spread out to dry as soon as removed from the solution.

QUANTITY OF SEED.

Low yields are frequently due to the use of seed too sparingly. According to the Bureau of Crop Estimates, the average quantity of seed used by the potato growers of the United States in planting an acre of potatoes is 8.6 bushels. It is believed that better yields would be obtained if from 15 to 18 bushels of seed per acre were used; in fact, under certain conditions there is every reason to suppose that a still larger quantity would be found profitable.

SIZE OF SEED.

As a result of many experiments, it has been shown rather clearly that a good-sized seed piece is preferable to a small-sized one. A seed piece containing from one to three eyes and weighing from 1 to 2 ounces (fig. 3) will, if properly spaced, say, 12 to 14 inches, give better results than smaller sized pieces cut to single eyes (figs. 4 and 5). The small-sized seed pieces are more liable to rot if the ground is cold and wet after they are planted and before they have germinated, and they are also more likely to dry up and fail to germinate if the ground is very dry or is poorly prepared. The smaller

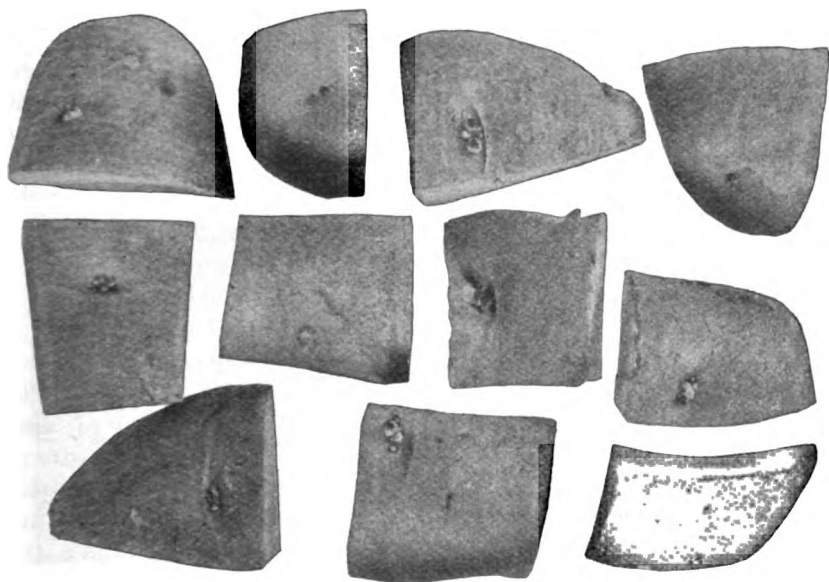


FIG. 5.—Completed operation in cutting the potato tuber shown in figure 4 into single-eye seed pieces.

the size of the seed pieces used, the more thoroughly must the seed bed be prepared and the more favorable must be the growing conditions between the dates of planting and actual germination in order to secure satisfactory results

CUTTING THE SEED.

APPARATUS USED IN CUTTING.

In cutting the tubers, aim to make the cuts at right angles to each other, in order to secure blocky rather than wedge-shaped pieces (figs. 3 to 5). Medium-sized tubers, or those running from 2 to 5 ounces in weight, are the most desirable for seed purposes, provided they have been produced by healthy and productive plants. The labor of seed cutting may be materially lessened by rigidly fasten-

ing the cutting knife in a vertical position with its cutting edge away from the operator, so that the motion in cutting is a drawing rather than a pushing one. The knife may be fastened in a 2 by 4 inch piece of lumber. Where any considerable quantity of seed is to be cut it will pay to construct a cutting box. This consists of a wooden hopper holding a barrel or so of seed potatoes. The bottom of the cutting box is inclined forward sufficiently to cause the potatoes to roll to the front, where they pass through the opening into a small shallow tray as the tubers are removed by the operator for cutting. The knife in this case is fastened to the tray. The cutting box is sufficiently elevated to permit beneath the knife the attachment of a sack into which the cut seed falls (fig. 6).



FIG. 6.—A seed-cutting box which greatly reduces the labor of cutting seed potatoes.

HANDLING THE CUT SEED.

When the seed is planted soon after it is cut, there is little, if any, need of special treatment except that when a planter is to be used the machine will handle the seed pieces better if they are dusted with

land plaster, flowers of sulphur, or air-slaked lime (fig. 7). Where large acreages are to be planted it is often necessary to cut the seed considerably in advance of the date of planting. In such cases the proper curing of the seed is a very important procedure. The improper handling of freshly cut seed has often been responsible for poor stands which have been thought by the growers to be due to poor seed. When not intended for immediate planting freshly cut seed should be stored in open crates or spread out in a thin layer on the storage-house floor or in a shed or barn and turned over once or twice during the first 24 hours and at least once a day for the next two or three days or until the cut surfaces have become dry. The use of an absorbent, such as land plaster or flowers of sulphur,

assists in the drying process. When freshly cut seed is stored in bulk it quickly develops enough heat to injure germination or to prevent it entirely. It is also very injurious to expose freshly cut seed to direct sunlight. An exposure of an hour or two, if the day is warm, is often sufficient to affect very seriously its germinating qualities.

PLANTING THE SEED.

The depth at which the seed pieces should be planted is directly dependent upon the character of the soil and the season of the year in which the crop is planted. In light sandy soils plant the early crop



FIG. 7.—Planting cut seed potatoes with a 1-row 2-horse planter at Spooner, Wis.

3 to 4 inches deep and the late crop 4 to 5 inches deep. On heavy types of soil plant early varieties from 2 to 3 inches deep and late ones 3 to 4 inches deep.

The distance at which the crop should be planted for best results is largely governed by the variety grown, the fertility of the soil, and the normal moisture supply. Early varieties, such as the Irish Cobbler, Triumph, and Early Ohio, may be planted in rows from 30 to 34 inches apart and from 10 to 12 inches apart in the row. Late varieties, such as the Green Mountain and the Rural, are ordinarily planted in rows 34 to 36 inches apart, with plants spaced 12 to 14 inches apart in the row.

In regions where the crop is grown under irrigation and ridging is a necessity, the distance between the rows may be as great as 42 inches. Likewise, in sections where the rainfall is light, as in the semiarid regions of the West, and irrigation water is not available, the rows are frequently 48 inches apart and the plants in the row from 24 to 36 inches apart.

TIME OF PLANTING.

The early crop should be planted as soon as danger from killing frosts, after the crop is up, is past and the condition of the soil will permit. The soil should be in a good friable condition. It should never be planted when it is wet enough to be sticky; neither should it be planted before it has been sufficiently pulverized to put it in good physical condition to receive the seed. In the South the risk from late spring frosts is an ever-present menace, and the grower is obliged to take certain risks in order to bring his crop to marketable maturity at as early a date as possible. In the North it is usually not possible to plant too early, because as a rule the soil can not be put in proper condition to receive the crop. In the South early crop planting may begin the latter part of November in southern Florida, ending in early April in Maryland and Delaware. In the Northern States the early crop is planted from the latter part of March to the latter part of May. Late-crop planting begins in the North in May and extends into the early part of September in the extreme South.

CROP PERIODS.

Seasonally speaking, potato planting may be divided into four more or less distinct crop periods, viz, (1) the early (or truck) crop of the South, (2) the early crop of the North, (3) the late crop of the North, and (4) the late crop of the South; in fact, the late crop of the South might be subdivided into the production of second-crop potatoes and late or fall crop potatoes. The early (or truck) crop of the South is largely marketed in the North and West, whereas the early crop of the North is largely grown to supply local markets. The late crop of the North is grown for fall, winter, and spring consumption and is widely distributed. Much of the late crop grown in the South is marketed locally. Virginia and Maryland may be regarded as exceptions to the above statement.

Second-crop production in the South is of special interest to potato growers, because it really involves two quite distinct practices. The first consists in the growing of a second crop from seed obtained from the first crop. This in our judgment is the only true second-crop potato production. The second practice consists in planting seed of the preceding year's crop (generally northern-grown seed) that has been

held over in cold storage until required for use. This practice does not differ essentially from that involved in the growing of a late southern crop, except that it is usually grown to furnish seed stock for the next season's crop. The chief points of interest to the potato grower in the production of second-crop potatoes from seed produced by the early crop are those pertaining to the handling of the seed and the localities where the crop is grown. The bulk of real second-crop potatoes is produced in Oklahoma, Arkansas, Texas, and to some extent in Louisiana. In other localities, as in the celebrated Louisville (Ky.) district, North Carolina, South Carolina, Virginia, and Maryland, the second crop is grown usually from stock held over from the preceding year. The most interesting feature, however, is that of the handling of the seed of the first crop. The following six practices have their advocates in Oklahoma and Arkansas:

Practice No. 1.—The first and apparently most general practice is that of planting the small or unsalable potatoes, really the culls, from the first crop immediately in the furrow made in harvesting these tubers, or of planting them on some previously prepared piece of land. This practice has the disadvantage of a slow and imperfect germination, making necessary the keeping down of weed growth on the land during the time between planting and the actual appearance of the plants above ground; or else, as frequently happens, the land gets weedy during this period.

Practice No. 2.—This practice differs from No. 1 in one respect: Instead of planting the culls immediately where they are to grow, a trench is opened up with a plow by throwing out one or more furrows in either direction. This trench is filled to a depth of 4 to 6 inches with the cull potatoes intended for seed purposes, after which the soil is thrown back over them. They are left in this condition until wanted for planting, which is usually three to five weeks, when the soil is thrown back and the potatoes sorted over. Only those that show sprouts should be selected for seed purposes, thus insuring a quick germination and a good stand of plants. The only drawback to this practice that has come to our attention is that when the weather is wet and the temperature high there is likely to be a heavy loss from tuber rots. By selecting a well-drained piece of land and covering the tubers with a fairly heavy layer of soil, much of this loss can be avoided.

Practice No. 3.—This practice differs from the other two in that the seed tubers are spread out on the ground in some shaded place, as under the house, in a shed, or under a tree, where they are allowed to remain for three to five weeks before planting. This allows the grower, as in practice No. 2, to select for seed purposes only those tubers which show signs of sprouting.

Practice No. 4.—This practice differs from No. 3 in but one detail, which is that the tubers are covered with a layer of straw or other coarse material which protects them from the light and to some extent lessens loss of moisture. Some growers keep this protective covering moist, claiming that more satisfactory results are thereby obtained.

Practice No. 5.—This practice is comparatively new. It consists in immediately placing the seed potatoes from the first crop in cold storage, where they are held at a temperature ranging from 32° to 34° F. for two to four weeks, after which they are taken out and allowed to warm up for a week or two be-

fore planting. The effect of the low temperature on the newly harvested tubers is to shorten the normal rest period and thus hasten germination.

Practice No. 6.—This practice may be and is, to some extent at least, combined with each of the preceding ones. It consists of clipping off the seed ends or other portions of the skin of small tubers instead of planting them whole. By this practice it is claimed that earlier and better germination can be secured than where the surface of the tuber is not mutilated. When the seed potato is cut the same result is attained. The actual effect of removing the skin or cutting the tuber is that of expediting the loss of moisture, which seems to result in a greater activity of the life processes of the plant, thereby inducing an earlier germination.

One general criticism applies to all of the practices mentioned, and that is that it is just as important to save good seed from the first crop as it is from the late one for the planting of the early crop. The



FIG. 8.—First deep cultivation of potatoes with a 2-horse riding cultivator, Churchland, Va.

practice of planting the culls should be regarded as an unprofitable one, from whatever angle it is viewed.

Practices Nos. 3 and 4 combined with No. 6 are considered most satisfactory.

GOOD TILLAGE.

OBJECTS OF TILLAGE.

The objects of tillage are to prevent weed growth, conserve moisture, aerate the soil, increase the available supply of plant food, and stimulate root action. The aim of the grower should be to keep the surface soil loose and open from the time of planting the crop until the damage from root injury is greater than the benefit derived by the plant from the loosening of the surface soil. Much hand hoeing may

be avoided by early cultivations with a spike-tooth harrow or a weeder run lengthwise of the rows. Cultivation may be continued with the harrow until after the plants are well above ground, provided it is so constructed that the teeth can be slanted backward. As soon as the plants are up they should receive as deep a cultivation as it is possible to give (fig. 8). At this stage of development the cultivator can be run quite close to the plants without injury to them. The next cultivation should be shallower and farther from the plants. The same rule should be observed for each subsequent cultivation. Frequency of tillage should be governed by seasonal conditions. A safe general rule to follow is to cultivate the crop whenever the soil needs it—that is, whenever a crust forms on the surface or weeds begin to grow. Weeds should never be permitted to take possession of the land.



FIG. 9.—First cultivation of potatoes just before the plants break through the ground. The loose soil is ridged up, as shown in figure 10.

COMPARISON OF RIDGE AND LEVEL CULTURE.

Two rather distinct cultural practices obtain in the growing of a potato crop, viz, the ridge method and the level-culture method. In the ridge method the soil after each cultivation between the rows (fig. 9) is ridged up around the plants by means of a wing or disk potato hoe, which pushes or throws the soil up around the plants (fig. 10). In the level-culture method the aim is to keep the soil level, or nearly so. Generally at the last cultivation the side shovels are set so as to throw some soil toward the plants, to protect the tubers near the surface from sunburn. The ridge method is practiced in Maine and certain other parts of New England, New York, Pennsyl-

vania in part, the South generally, and the irrigated sections of the West. Level culture is largely practiced in Ohio, Indiana, Michigan, Wisconsin, Minnesota, and the Dakotas. With the ridge system of culture, cultivation can be continued somewhat later in the season than with level culture, because few of the roots of the ridged plants extend beyond the ridge; hence tillage in the center of the row and ridging up the loose soil does not injure the roots, as in level culture, where they spread out through the adjacent soil.



FIG. 10.—Ridging the soil with a 2-row disk potato hoe, Aroostook County, Me.

POTATO DISEASES.

For the sake of convenience, the common diseases of the potato are presented in tabular form, and the nature of the injury and remedy or preventive measure to employ are indicated. (Table II.)

TABLE II.—Common diseases of the potato; also preventive measures.

Name of the disease.	Injury to—	Remedy or preventive measures.
Early-blight.....	Leaves of the plant.....	Spray with Bordeaux mixture.
Late-blight.....	Leaves, stems, and tubers...	Spray with Bordeaux mixture; plant disease-free seed.
Fusarium blight.....	Roots, stem, and tubers....	Plant clean seed; rotate crops.
Rhizoctonia.....	do.....	Plant clean or disinfected seed. ^a
Verticillium wilt.....	Stem and tubers.....	Plant disease-free seed; rotate crops.
Mosaic.....	Foliage, stem, and tubers...	Plant disease-free seed.
Leaf-roll.....	Leaves, stems, and tubers...	Do.
Common scab.....	Tubers and to some degree the roots.	Disinfect the seed tubers as previously directed and avoid soils known to produce scabby potatoes.

^a Detailed directions for potato-seed treatment will be found in Circular No. 3 of the Office of Cotton, Truck, and Forage Crop Disease Investigations. Potato diseases are discussed in Farmers' Bulletin 544, entitled "Potato Tuber Diseases," while directions for spraying are given in Farmers' Bulletin 868, entitled "How to Increase the Potato Crop by Spraying."

INSECT AND EELWORM PESTS.

The potato has its full share of insect pests. Some of these enemies attack the foliage or the stem of the plant, while others attack the roots and the tuber. For the sake of convenience they may be divided into the following groups: (1) Chewing, (2) sucking, and (3) piercing or tunneling insects. The first division includes the Colorado potato beetle, the old-fashioned potato beetle, or blister beetle, and the flea beetle. The second division includes the plant louse, or aphid, and the apple leafhopper. The third division embraces flea-beetle larvæ, the potato tuber moth, and the eelworm. The latter, however, is an animal rather than an insect parasite.

The first two leaf-chewing insects are easily controlled by spraying the plants with arsenical poisons. The flea beetle is more difficult to control, as it eats very much less of the foliage. It is most effectively controlled by keeping the foliage well covered with Bordeaux mixture to which an arsenical poison has been added. The Bordeaux spray acts as a repellent by making the foliage distasteful to the flea beetle.

The plant louse and apple leafhopper, on account of the way they obtain their nourishment from the plant—that is, by sucking its juices—can not be destroyed by applying poison to the foliage. The only effective way of controlling these two pests is by thoroughly spraying the plants with a contact insecticide, such as nicotine-sulphate solution (40 per cent nicotine) or with kerosene emulsion.* Effective control of these two insect pests is largely dependent upon the early spraying of the plants and the thoroughness with which the work is done. To be effective the under side of the leaves must be more thoroughly sprayed than the upper, because the insects congregate on the lower side. The apple leafhopper is a comparatively new potato insect pest, at least it has only recently attracted the attention of the entomologist and the potato grower. It is claimed that thorough spraying with Bordeaux mixture in connection with nicotine-sulphate solution (40 per cent nicotine) serves as a repellent.

Injury from these two pests is largely confined to the northeastern United States. The apple leafhopper is especially troublesome in the Middle West.

The potato tuber moth is largely restricted to California. It attacks leaves, stems, and tubers and in some localities causes very material loss. Preventive measures, such as crop rotation, destruc-

* Nicotine-sulphate solution (40 per cent nicotine) may be used at the rate of 1 pint to 100 gallons of water. Kerosene emulsion is made by dissolving one-half pound of hard soap or whale-oil soap in a gallon of boiling hot water and when still hot adding 2 gallons of kerosene oil. This mixture should be churned into itself by means of a small hand pump until the solution is completely emulsified. (For fuller information upon this subject, consult *Farmers' Bulletin 856*, entitled "Control of Diseases and Insect Enemies of the Home Vegetable Garden," p. 8.)

tion of old potato plants, and prompt harvesting and disposal or storage of the crop as soon as dug, help to minimize the injury. Tubers containing the larvæ of the tuber moth or that carry eggs on their surface when stored should be fumigated with carbon disulphid at least twice, to prevent further increase of the insects as well as the destruction of those present in or on the tuber. For fuller information consult United States Department of Agriculture Bulletin 427, entitled "The Potato Tuber Moth" (p. 50).

The eelworm is an animal parasite. It is widely distributed, but as a rule is not a serious pest of potatoes except in certain portions of the Pacific coast region, particularly in parts of California, and in the Southern States. As the eelworm lives over in the roots of many plants and confines its attacks to the roots and tubers of the potato plant, it is not possible to destroy it with arsenical poisons or contact sprays. Crop rotations, soil sanitation, and the use of clean seed are recommended as preventive measures.

SPRAYING THE PLANTS.

SPRAY MIXTURES.

Strong, vigorous potato plants are dependent in no small measure upon the degree of protection given them by thorough spraying with fungicides or insecticides, or both, throughout the growing season. Spray with Bordeaux mixture for the control of early-blight and late-blight. Begin spraying the plants with Bordeaux mixture as soon as they are 6 to 8 inches high. Add Paris green, arsenate of lead, arsenate of calcium, or arsenite of zinc to the Bordeaux spray whenever the bugs become injurious. An acre of potatoes can be easily sprayed by hand, but if a power sprayer is available it will be found more economical to use it. Of the strictly hand sprayers, the auto-spray and the knapsack sprayer are the best types. The barrel spray pump is the most efficient hand-operated spray apparatus. It requires two men to operate it satisfactorily. Where the early-blight and the late-blight do not prevail, spraying with Bordeaux mixture is unnecessary.

The formulas for Bordeaux mixture, arsenical poisons, etc., are as follows:

Bordeaux mixture.—Dissolve 5 pounds of copper sulphate in 20 gallons of water. Slake 5 pounds of lime in water and dilute to 20 gallons. Pour the copper sulphate and lime solutions together, stirring thoroughly. Add water to make 50 gallons.

Arsenical poisons.—(1) Paris green, 8 to 12 ounces; slaked lime, 2 pounds; water to make 50 gallons.

(2) Arsenate of lead paste, 3 to 5 pounds; water to make 50 gallons.

(3) Arsenite of zinc, 1 to 2 pounds; water to make 50 gallons.

Contact insecticides.—Nicotine-sulphate solution (40 per cent nicotine) : 1 pint to 100 gallons of water.

Kerosene emulsion: One-half pound of hard soap or whale-oil soap; 1 gallon of boiling water; 2 gallons of kerosene oil. Dilute to 50 gallons.

Gaseous insecticide.—Carbon disulphid: 2 pounds to 1,000 cubic feet. Expose 48 hours.

When the Paris green is used with the Bordeaux mixture, no further lime is necessary.

NUMBER OF SPRAYINGS.

Spray as often as may be necessary to keep the foliage well covered with fungicides or insecticides as long as there is apparent danger. This may be two, four, six, eight, or more times, depending on whether one is in a late-blight infected area and if the season is favorable to the development of the disease. A serious infection of late-blight has been observed after September 15 in western New York.

When full grown it will require from 100 to 125 gallons of Bordeaux mixture to cover the foliage of an acre of plants thoroughly.

ROGUING AND SELECTING FOR SEED.

Where it is possible to produce good seed potatoes—that is, in localities where the climatic conditions are favorable to the development of good strong seed stock—a portion or all of the acre should be carefully gone over during the growing season and all diseased or weak plants or mixtures pulled out. Especially promising looking plants should be marked and dug separately before the rest are harvested. The progeny of these plants should be kept for seed. The best of these selections should be saved the following year and should eventually furnish high-grade seed stock for the acre plat (fig. 11). High-grade seed stock can be maintained only through a continuous process of selection (fig. 12).

HARVESTING THE CROP.

The easiest way to harvest the crop is to dig it with a horse-drawn elevator digger (fig. 13). The next easiest is to use a digger plow, with rocking fingerlike attachment, to separate the tubers from the soil. It is less easy to plow them out with a 1 or 2 horse turnplow, and the hardest way from a physical-labor standpoint is to dig them by hand (fig. 14).

Seed for next year's crop should be selected at digging time. Avoid all inferior-looking tubers, and, as far as may be, take tubers from productive plants only. Slat crates make very convenient receptacles for the storing of seed potatoes. After selecting the desired quantity

of seed, the remainder of the crop may be all picked up together and put into the storage house or cellar for sorting later, or graded into marketable and unmarketable stock and sold direct from the field.

GRADING.

The establishment of standard potato grades is an outcome of the late World War. We now have three standard grades of potatoes: U. S. Grade Fancy; U. S. Grade No. 1; and U. S. Grade No. 2. The first has recently been established to meet the demands of certain

western growers who wish to put up a fancy or select grade of potatoes.

The following description of these grades is taken from United States Department of Agriculture Circular 96, prepared by Hartley E. Truax:



FIG. 11.—Selecting well-shaped potato tubers in the field.

U. S. Grade Fancy.—This grade shall consist of sound potatoes of one variety which are mature, bright, smooth, well shaped, free from dirt or other foreign matter, frost injury, sunburn, second growth, growth cracks, cuts, scab, blight, soft-rot, dry-rot, and damage caused by disease, insects, or by mechanical or other means. The range in size shall be

stated in terms of minimum and maximum diameter or weight following the grade name, but in no case shall the diameter be less than 2 inches.

In order to allow for variations incident to commercial grading and handling, 5 per centum by weight of any lot may vary from the range in size stated, and, in addition, 3 per centum by weight of any such lot may be below the remaining requirements of this grade; but not more than one-third of such 3 per centum, that is to say, not more than 1 per centum by weight of the entire lot may have the flesh injured by soft-rot.

U. S. Grade No. 1.—This grade shall consist of sound potatoes of similar varietal characteristics which are practically free from dirt or other foreign matter, frost injury, sunburn, second growth, growth cracks, cuts, scab, blight,

soft-rot, dry-rot, and damage caused by disease, insects, or mechanical or other means.

The diameter of the potatoes of the round varieties shall not be less than $1\frac{1}{2}$ inches, and of potatoes of long varieties, $1\frac{1}{2}$ inches.

In order to allow for variations incident to commercial grading and handling, 5 per centum by weight of any lot may be under the prescribed size, and, in addition, 6 per centum by weight of any such lot may be below the remaining requirements of this grade; but not more than one-third of such 6 per centum, that is to say, not more than 2 per centum by weight of the entire lot, may have the flesh injured by soft-rot.

U. S. Grade No. 2.—This grade shall consist of potatoes of similar varietal characteristics which are practically free from frost injury and soft-rot and



FIG. 12.—Studying type specimens of potatoes, an essential in learning the good as well as the undesirable characteristics of a variety.

which are free from serious damage caused by sunburn, cuts, scab, blight, dry-rot, or other disease, insects, or mechanical or other means.

The diameter of potatoes of this grade shall not be less than $1\frac{1}{2}$ inches.

In order to allow for variations incident to commercial grading and handling, 5 per centum by weight of any lot may be under the prescribed size, and, in addition, 6 per centum by weight of any such lot may be below the remaining requirements of this grade; but not more than one-third of such 6 per centum, that is to say, not more than 2 per centum by weight of the entire lot, may have the flesh injured by soft-rot.

STORAGE.

The object of storing any product is to preserve its quality during as long a period as may be necessary or possible in order to permit its disposal at the most advantageous time. The temperature best suited to the proper preservation of potatoes is one ranging from 32° to 40° F. In regions where the powdery dry-rot occurs a tem-

perature of 33° to 36° F. holds the disease in check better than a higher one.

Do not store potatoes in large piles when they are moist or covered with moist earth, as they quickly develop sufficient heat to injure the vitality of the tubers. If through unfavorable weather conditions it becomes necessary to store potatoes when they are wet and dirty, spread them out in a thin layer until they have become dry, after which they may be piled up. It is not desirable to store potatoes to a greater depth than 6 feet.



FIG. 13.—A horse-drawn elevator potato digger. This implement harvests the crop, leaving the tubers on the surface of the ground.

Potatoes intended for table use should always be stored in a darkened cellar or storage house. Exposure to light quickly injures the quality of the potato for food purposes.

SUMMARY.

The average production of potatoes in the United States during the years 1910 to 1919 was 96.8 bushels per acre, while during the same period that in the State of Maine was 201 bushels.

Commercial yields of 500 to 600 bushels per acre are by no means uncommon, and on small areas much larger yields have been secured by members of boys' and girls' agricultural clubs.

Intensive rather than extensive potato production is necessary under present economic conditions. Increased production per acre at a reduced cost per bushel should be the goal of every progressive potato grower in the United States. Increased production per acre is dependent upon many factors.

A suitable soil is important; gravelly or sandy loam soils are best. Clover or alfalfa is a good preparatory crop. The soil should be well plowed and thoroughly pulverized before the crop is planted. Fall plowing and spring plowing each has its advocates. As a rule, fall plowing is the more desirable.



FIG. 14.—Digging potatoes by hand. This is the hardest way to harvest the crop, but if carefully done it causes the least mechanical injury to the tubers, and when the diggers leave the progeny of each hill by itself the process of selecting seed stock by hills may be employed.

The selection of the right variety is an important step in the production of a good crop. An early variety should be selected for the early market and a late or medium-late maturing one for autumn and winter consumption.

The available plant-food supply in the soil or applied to the crop is one of the main determining factors as to the yield secured. The plants must be well fed if they are to produce a large crop of tubers.

Different percentages of the three chemical elements, nitrogen (ammonia), phosphoric acid, and potash, should be applied to different types of soil to secure the best results.

High-grade seed stock must be used if a large crop is to be harvested.

Different strains of seed of the same variety vary greatly in their productive capacity. Every effort should be made to secure high-yielding seed stock.

All seed stock should be disinfected in a formalin or corrosive-sublimite solution before cutting.

As a rule, the quantity of seed planted is too small to produce maximum acre yields.

Seed pieces weighing from 1 to 2 ounces and containing from one to three eyes will give better acre yields than smaller sized pieces cut to single eyes.

The seed piece should be so cut as to give a blocky rather than a wedge shape.

The depth of planting should be varied to conform to the character of the soil and the season of the year.

The spacing of the rows and of the plants in the row is dependent upon the variety, the climate, and the character of the soil.

The time of planting is naturally governed by the disposition to be made of the crop; also by the weather conditions.

Seasonally speaking, there are four crop periods: (1) The early or truck crop of the South, (2) the early crop of the North, (3) the late crop of the North, and (4) the late crop of the South.

The late crop of the South should be subdivided into (1) the planting of early-maturing varieties in midsummer for the purpose of producing second-crop seed to be used in the planting of the early crop the ensuing year and (2) the planting of late-maturing varieties for fall and winter consumption.

Good tillage is necessary if a good crop is to be harvested.

Potato diseases may be controlled by the rigid removal of all diseased seed tubers, by treatment of tubers used for seed, by spraying the foliage, and by roguing out diseased plants.

Potato plants must be protected from insect injury if large yields are to be secured. Leaf-chewing insects may be controlled by arsenical poisons; sucking insects by contact insecticides.

Well-graded potatoes will always bring a better price than poorly graded ones.

A good storage house or cellar is necessary if the potato crop is to be held for winter or spring marketing.

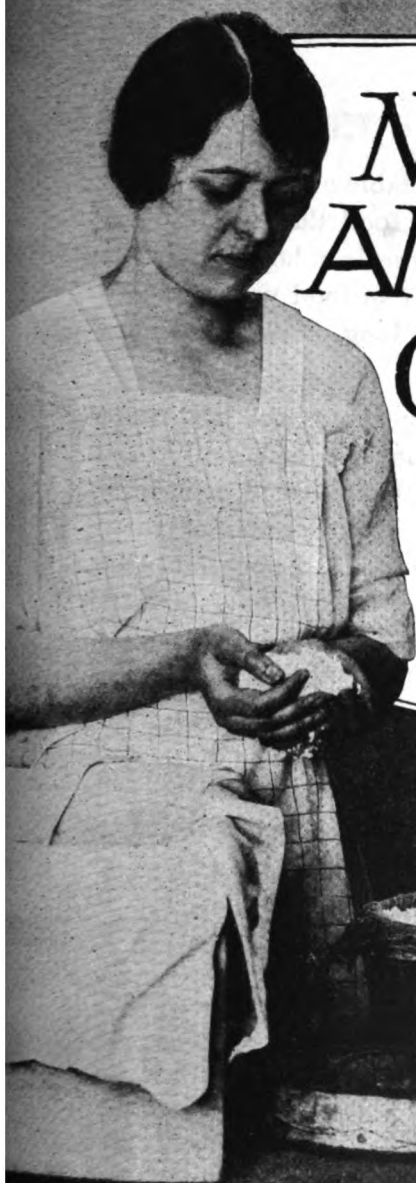
Light is injurious to the table quality of the potato.

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FARMERS' BULLETIN -- 1191
UNITED STATES DEPARTMENT OF AGRICULTURE



MAKING AMERICAN CHEESE ON THE FARM



A **AMERICAN CHEESE**, palatable and rich in body-building materials, is a food that is not fully appreciated in the average American home. Cheese compares favorably with beef in food value, and in addition may be kept for long periods without refrigeration.

The farm home especially could well afford to use more cheese. The farmer and his family lead an active, vigorous life, and they must be especially well nourished to meet the requirements of farm work. Cheese furnishes muscle and body-building material in abundance, and with a supply of milk for cheesemaking on the farm there is no reason why the farmer should not have this good food on his table.

Contribution from the Bureau of Animal Industry

JOHN R. MOHLER, Chief

Washington, D. C.

June, 1921

MAKING AMERICAN CHEESE ON THE FARM.

C. M. GERE, *Dairy Division.*

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Cheese may be made at any time of the year, and on farms where there is a surplus of milk during certain seasons cheesemaking offers an exceptionally advantageous means of conserving, for later use, milk which otherwise might be wasted. The making of cheese does not require a great deal of time, and if good milk is used and directions are followed no one should have difficulty in making good cheese.

Approximately five or six hours are required from the time the milk is placed in the vat for heating until the cheese is put into the hoop for final pressing, and during that time it is not necessary for the operator to give it his entire attention. From this point until the end of two weeks only a few minutes are required each day to turn the cheese. After that time the cheese is turned only twice a week until fully cured.

For making cheese in small quantities on the average farm the Cheddar process used in factories is somewhat too complicated to be practicable. With the more simple method, known as the hand-stirred or granular process, presented in this bulletin, however, good cheese can be produced on the farm.

CONDITIONS FAVORABLE FOR FARM CHEESEMAKING.

Best results have been obtained in regions where the nights are cool throughout the summer and where cool water may be obtained. These factors favor the production of a high-quality cheese. Where these conditions do not exist it is more difficult to produce a high-quality cheese during warm weather, as gas-producing bacteria are more abundant at that time.

Only whole milk should be used, as skim-milk cheese made by this method is hard, dry, and lacking in flavor.

Because the market requires a uniform product it is not generally economical or practicable to make farm cheese for the general mar-



FIG. 1.—Wood-jacketed cheese vat.

ket. Cheese that is satisfactory for home consumption, however, can be made wherever a supply of fresh, clean milk is available.

YIELD OF CHEESE.

Approximately $10\frac{1}{2}$ pounds of cheese are obtained from 100 pounds ($11\frac{1}{8}$ gallons) of milk containing 4 per cent butterfat. The yield varies with the fat content of the milk and also with the quantity of solids lost in the process of manufacture. A cheese of any size may be made.

It is important to have fresh, clean milk for cheesemaking. If milk is to be kept overnight it should be cooled to a temperature of 60° F. or lower and held at that temperature until used. The milk should not be held more than 12 hours, as it is very essential that the milk be perfectly sweet.

THE CHEESE VAT.

A wash boiler, large kettle, or tub may be used for cheesemaking, but if cheese is to be made frequently or on a fairly large scale a regular cheese vat is more satisfactory. A cheese vat is so constructed that hot or cold water may be circulated around the milk for regulating the temperature.

Having control of temperature throughout the manufacturing process is essential to the successful making of cheese. A good thermometer therefore should be used.

The milk is heated in the vat or wash boiler to a temperature of 86° F., at which it is held until after the curd has been cut.

COLORING.

Cheese made without the addition of coloring matter is light yellow or straw color. If a deeper shade of yellow is desired a small

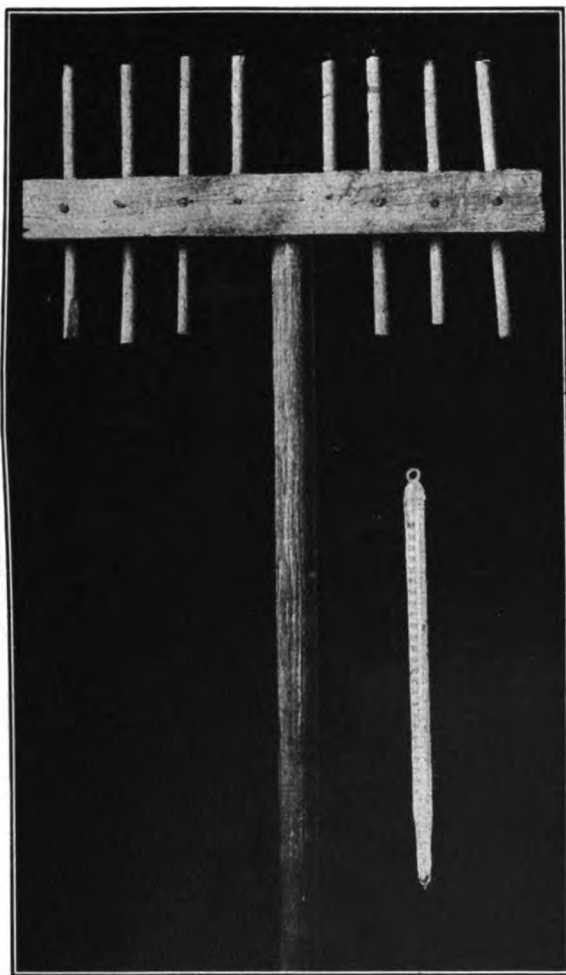


FIG. 2.—Homemade rake for stirring the curd. Floating dairy thermometer at right.

quantity of coloring is put into the milk. Regular cheese color should be used and not butter color, as the latter colors the fat but not the curd. From $\frac{1}{2}$ to 1 teaspoon of cheese color to 100 pounds of milk is sufficient. The color should be stirred thoroughly through the entire mass of milk.

ADDING RENNET.

Rennet extract, which is used to curdle the milk, may be obtained from a dairy-supply house. If the extract is not available rennet

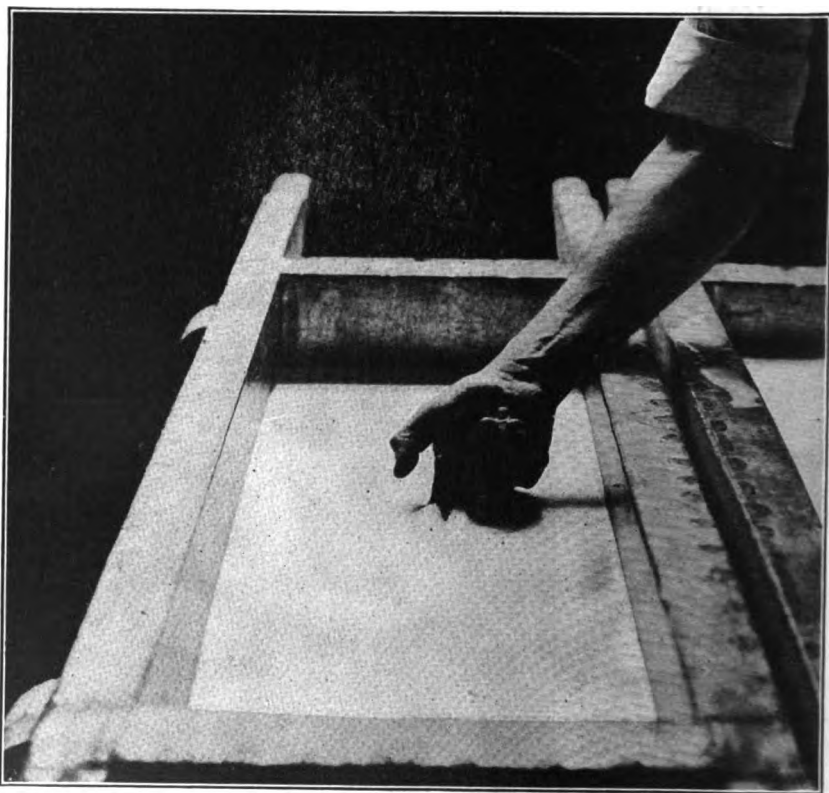


FIG. 3.—Trying the curd. The curd is ready to cut when it splits smoothly over the finger.

tablets may be used, which sometimes may be obtained at drug stores. Rennet should be added at the rate of $\frac{1}{2}$ ounce or 2 teaspoons for each 100 pounds of milk, or enough to curdle the milk in from 30 to 45 minutes. The rennet should first be mixed with a pint of cool water and then stirred into the milk very thoroughly, and the stirring continued slowly for about 3 minutes. It is very important that the temperature of the milk at this time be 86° F. and that it remain at this temperature until the curd is properly set, which should be in

from 30 to 45 minutes, depending upon the quantity of rennet used, the acidity, and other qualities of the milk. After the rennet has been stirred in, the milk must stand undisturbed until curdled. If there is the slightest motion to the milk while curdling the curd will not be firm. The vat should be covered to keep the surface of the milk from cooling.

CUTTING THE CURD.

The curd must be cut at the right stage of firmness. If cut when too soft it will be broken up, resulting in a loss in yield, or if allowed to get too hard it will be cut with difficulty. The usual method of determining the proper stage for cutting is to insert the forefinger in the curd at an angle of 45° and about $\frac{1}{2}$ inch under the surface. The finger is then raised slightly and the curd split with the thumb. If the curd splits smoothly without leaving particles on the finger it is ready to be cut. Special curd knives may be obtained for cutting the curd into cubes of equal size. Uniformity in the size of these cubes is necessary to insure uniform firming of the curd. The curd should first be cut lengthwise of the vat with a horizontal curd knife and then cut crosswise with a vertical knife, and finally lengthwise with the vertical knife, thus leaving the curd in small cubes. To insure a maximum yield of cheese it is necessary to avoid crushing the curd or breaking it into very small pieces. The curd knives should be inserted and removed from the curd in such way as to cut the curd rather than to crush it. The horizontal knife should be placed in the vat as shown in figure 5, and moved slowly to the opposite end of the vat, where it is turned halfway round, and not removed from the vat until all the curd has been cut.

If curd knives are not available the curd may be cut with a large butcher knife, cutting both lengthwise and crosswise of the vat, and then, after carefully giving the curd a quarter turn so that one side is now on top, cutting lengthwise again. When the cutting has been completed the pieces of curd should be about $\frac{3}{8}$ inch in size, each dimension.

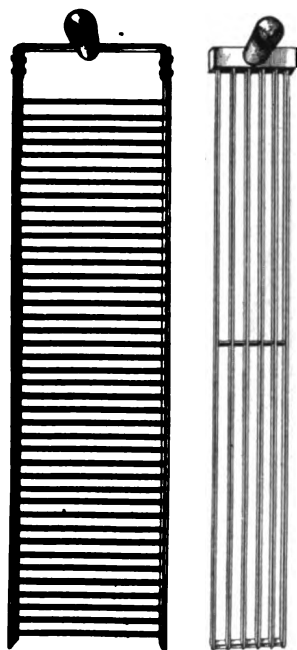


FIG. 4.—Curd knives, for cutting horizontally and vertically.

HEATING AND STIRRING THE CURD.

As soon as the curd is cut it should be stirred gently in order to prevent the pieces from sticking together and forming large lumps. The cubes of curd contract slowly and expel whey. As soon as a considerable quantity of whey is separated from the curd, usually in about 15 or 20 minutes, heating should be started. It is very important to raise the temperature very slowly, at the rate of about 2

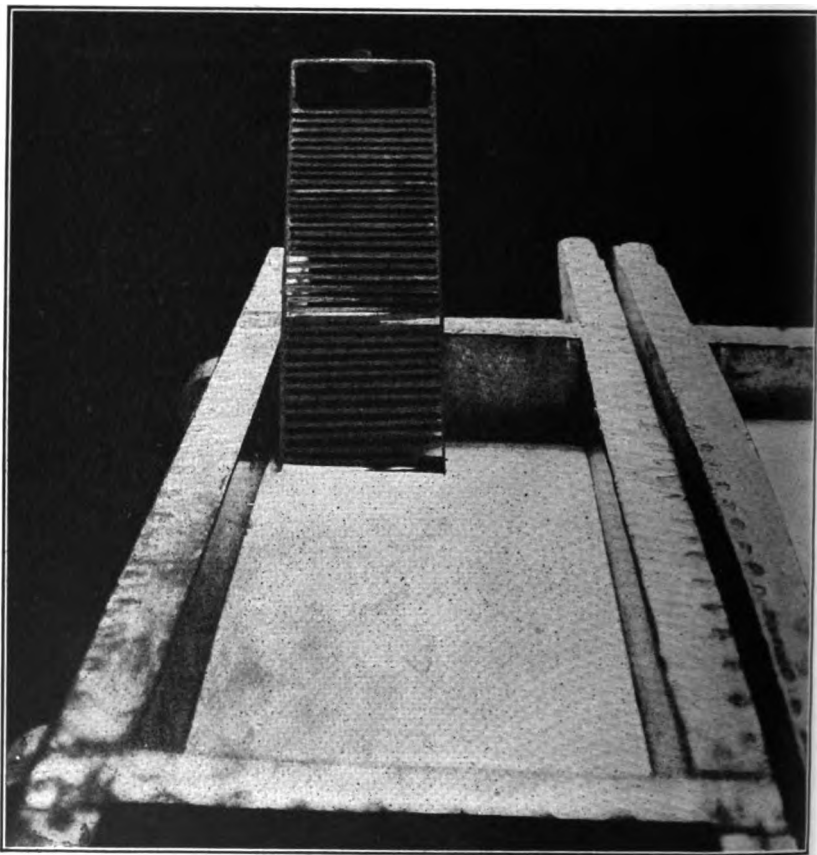


FIG. 5.—Inserting the horizontal curd knife.

degrees in 5 minutes, until a temperature of 100° F. is reached. Various methods of heating the curd may be used. There is less danger of heating too rapidly, however, if some of the whey is dipped out, heated to about 140° F., and gradually poured back into the vat. During the entire heating process the curd should be stirred just enough to keep the small cubes from matting together. The curd should remain in the whey at a temperature of 100° F. until it is firm and is sufficiently acid.

If the cheese is made in a vat or other large vessel it will be found convenient to use a rake for stirring the milk and curd. A rake like the one shown in figure 2 can easily be made at home.

TESTING FOR FIRMNESS.

The proper degree of firmness of the curd may be determined by pressing a mass of it between the hands. If when suddenly freed

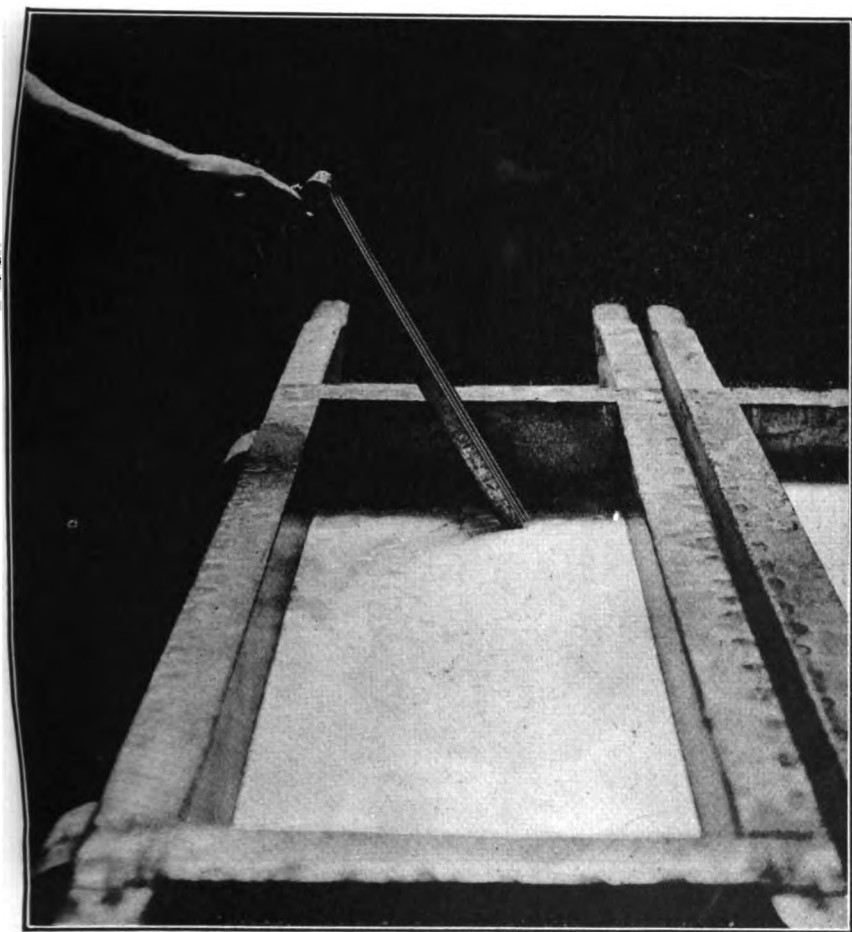


FIG. 6.—Inserting the vertical curd knife.

from pressure the pieces fall apart at once and show no tendency to stick together, the curd is of the proper firmness. (Fig. 7.) At this stage the cubes have contracted to about one-half the size they were when the curd was cut. If the curd becomes too firm, the cheese will be dry and "corky," while, on the other hand, if the curd is not firm enough, the cheese will be soft, too moist, and likely to sour.

TESTING FOR ACIDITY.

The amount of acid which is allowed to develop in the curd before removing the whey is the most important step in the cheesemaking process. The curd while in the whey should be closely watched to prevent the development of too much acid, as a curd that is overacid produces a dry, mealy cheese with a sour flavor, while a curd with too little acid is likely to develop gas and bad flavors during the curing process and does not keep well.



FIG. 7.—The proper degree of firmness in the curd.

The proper amount of acid to develop in a curd before removing the whey may be determined by pressing a little curd in the hand, pressing gently but with increasing firmness for about a minute, or until the particles adhere and moisture is expelled. This piece of curd is rubbed gently on a clean, hot iron until it adheres and is then very slowly and carefully pulled away from the iron. If in doing this fine silklike threads $\frac{1}{4}$ to $\frac{1}{2}$ inch long are formed, the whey should be removed. If threads do not form, sufficient acid has

not yet developed, and the curd should be left in the whey to permit the development of acid. During this period occasional stirring is required to prevent matting. The iron should be just hot enough so that the curd will stick to it and not burn the fine threads. (Fig. 8.)

REMOVING THE WHEY.

As soon as the curd is firm and the proper amount of acid has been developed, the whey should be removed. The curd is allowed to settle, the free whey is dipped off, and the curd is then placed on the

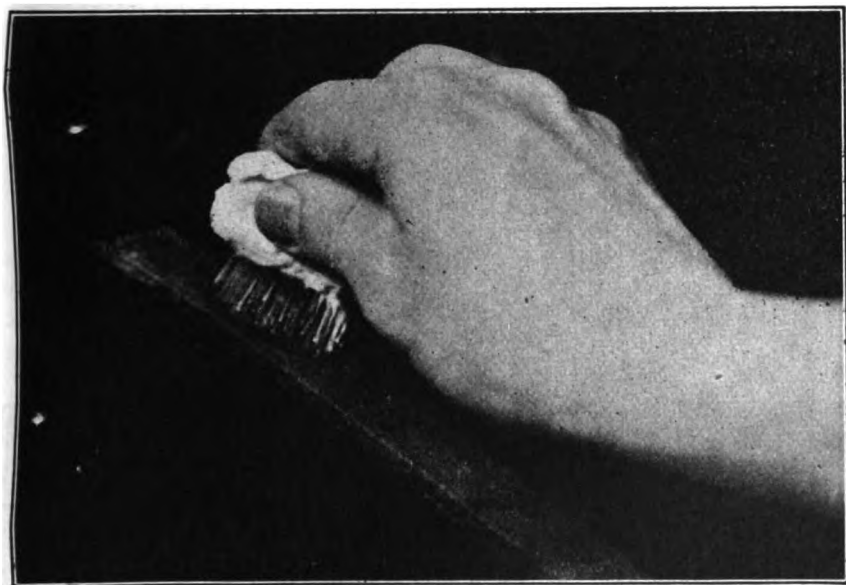


FIG. 8.—The hot-iron test. The curd is ready for pressing when it sticks to a hot iron and is drawn out in threads which break when about $\frac{1}{2}$ inch long.

rack to drain. While on the draining rack the curd should be stirred continuously until all the free whey has escaped; after that it should be stirred every 5 or 10 minutes to prevent it from matting together, and to keep it broken into pieces of the size of a large hickory nut. The curd should be kept warm and as near 100° F. as possible, to permit the development of acid. This may be accomplished by keeping the curd covered with a muslin cloth, and if a jacketed vat is used, warm water may be employed also.

A simple and inexpensive draining box can be made from a wooden box about 2 feet square and 8 inches deep. A close-fitting V-shaped bottom, sloping from both sides toward the center, should be provided. The lower edge of the V-shaped bottom should be on a level with the bottom of the box and the sloping sides should meet the box

sides 3 inches from the bottom, giving a slope of about 3 inches to the center. This provides drainage for the whey which drips from the rack placed above.

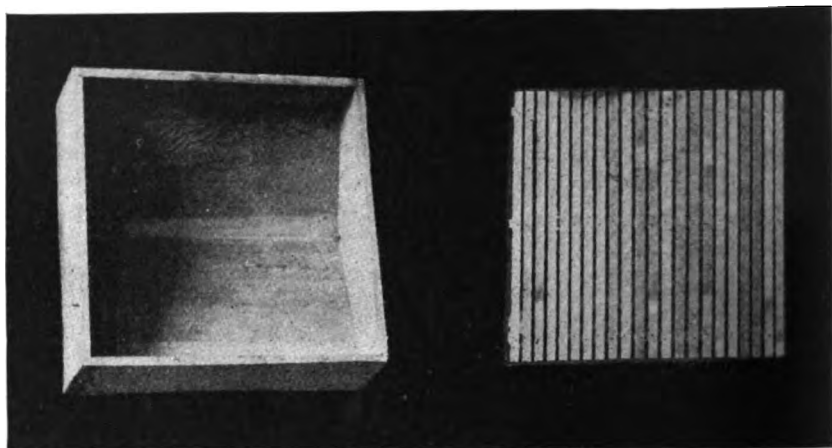


FIG. 9.—Home-made draining box and rack.

The rack is made of slats one-half inch thick and three-fourths inch wide, set one-fourth inch apart and nailed to crosspieces. A three-fourths-inch hole should be made in the end of the drain box near the bottom to allow the whey to drain from underneath the

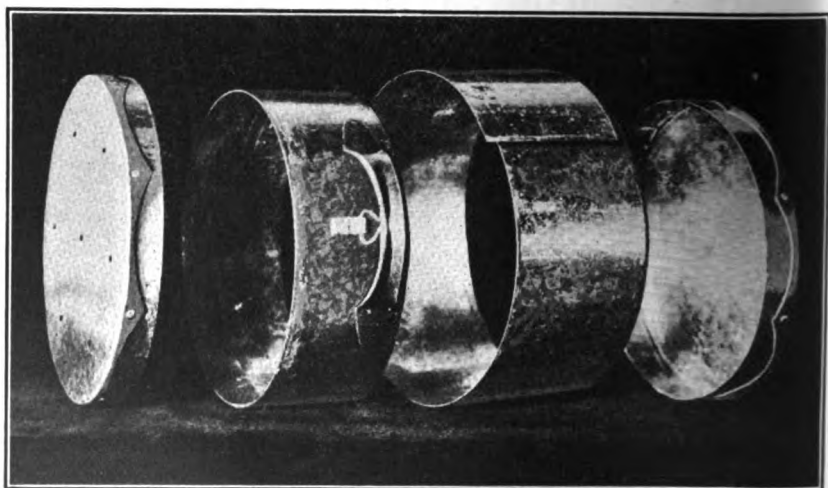


FIG. 10.—Parts of the cheese hoop. Left to right: Top; body, or closed hoop; bandager; bottom.

rack. Before dipping the curd into the draining box a muslin cloth should be spread over the rack to prevent the curd from passing down between the slats.

If only a small amount of cheese is to be made, a large kettle or dish pan may be used for draining the curd. A rack can be made to fit these receptacles, leaving a space underneath the rack which will serve as a reservoir for the whey that drains from the curd.

In case a vat is used for making cheese, no draining racks will be needed. The whey is drawn off through the faucet provided for that purpose. The draining and other operations necessary before the curd is ready to be pressed are completed in the vat.



FIG. 11.—The cheese hoop assembled.

SALTING THE CURD.

The stage for salting the curd is determined by the hot-iron test. When the curd shows fine silklike threads from three-fourths to 1 inch in length when rubbed on a clean, hot iron, the salt should be added. About 3 ounces of salt for each 10 pounds of curd is sufficient. After the salt has been thoroughly stirred through the curd it should be allowed to dissolve and the curd allowed to cool to a temperature of about 85° F. before it is put into the press.

PREPARING THE PRESS AND HOOPS.

A very good cheese press, shown in figure 13, can be made easily and quickly. A hoop or mold for pressing the cheese can be made

from galvanized-metal sheeting, the most convenient size being 7 or 8 inches in diameter and 10 inches in height. A wooden bottom should be made to fit inside the hoop, and a number of $\frac{3}{16}$ -inch holes bored in it to allow the whey to escape.

Cheese hoops may be obtained from dairy-supply houses; the Young America style, making a cheese of from 5 to 10 pounds, is suitable for farm use.

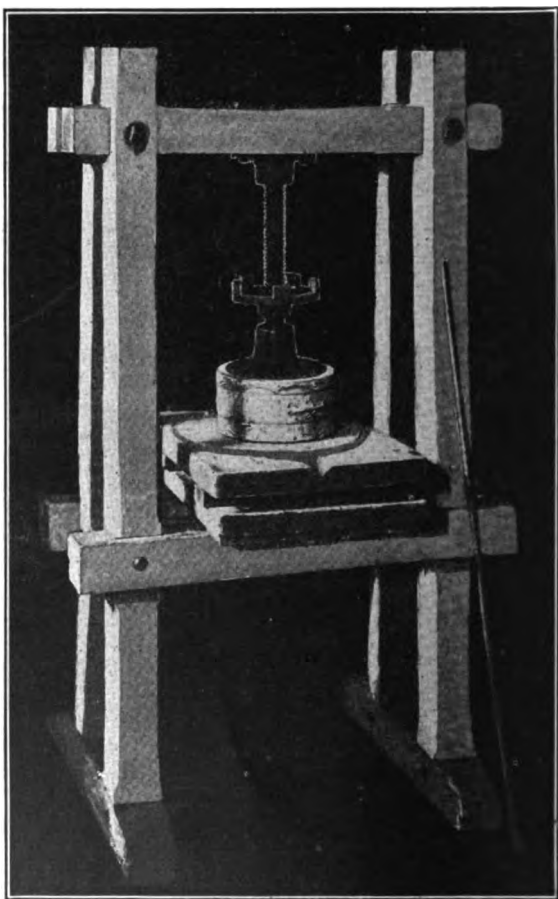


FIG. 12.—Screw-type cheese press.

In order to aid in the formation of a good rind and to improve the appearance of the cheese, a cheesecloth covering is used. Before putting in the curd the hoop is lined with cheesecloth, which is left on the finished cheese.

The cloths for this purpose are of two styles: (1) Circles of the diameter of the cheese for the top and bottom; (2) a bandage made by sewing cheesecloth into a "sleeve" that will fit very snugly into the cheese hoop.

In preparing the hoop for the curd a circle of cloth is placed in the bottom, then the bandage is put in, with the seam on the inside, overlapping on the bottom about 1 inch and extending high enough so that it can be turned over the upper edge of the hoop and held in place.

If a regular cheese hoop is used the bandage should be put over the part known as the bandager and this placed inside the closed hoop.

PRESSING THE CURD.

After the salt is dissolved and the curd cooled to 85° F. it should be put into the hoop and pressed. Pressure should be applied gently at first in order to avoid squeezing butterfat out of the curd. To do this a weight should be placed on the lever of the press about

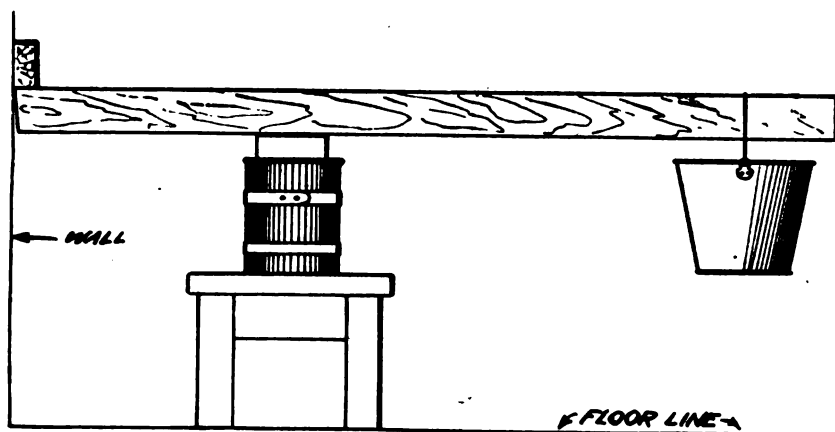


FIG. 13.—Home-made cheese press. The cheese hoop should be placed about 3 feet from the wall. Moving the weight outward on the lever increases the pressure.

halfway between the hoop and the end of the lever, which should be about 12 feet long (see fig. 13). A pailful of stones weighing 35 or 40 pounds makes a suitable weight. After half an hour the weight should be moved to the end of the lever and allowed to remain about an hour. Then the cheese should be taken out and dressed.

DRESSING THE CHEESE.

To dress a cheese it is first removed from the hoop and dipped in warm water; the cloth circles are then removed from both ends and all wrinkles drawn from the side bandages. If the side bandage laps over the ends of the cheese too much it should be cut off, allowing only about an inch lap over each end of the cheese. The end circles are then replaced, using plenty of warm water to insure the

formation of a good rind. The side bandage should not be removed at any time during the curing process. After the cheese has been properly dressed it should be put into the press and full pressure applied for 24 hours.

CURING THE CHEESE.

Curing is an important part of cheesemaking. Both the temperature and humidity should be under reasonable control. If properly ventilated, a cellar is probably the best place, during hot weather, for curing cheese on the farm. If it is desired to cure cheese quickly it



FIG. 14.—The finished cheese ready for the curing room.

may be kept at a temperature of 65° or 70° F., but a temperature of from 50° to 60° F. is regarded as the most favorable. Should mold appear on the cheese, the shelves should be wiped with a dry cloth when the cheeses are turned. If the cheese molds badly, it should be scrubbed with strong brine and placed in a drier curing room. When cheeses are placed in the curing room they should be turned daily until they are paraffined, after which they need not be turned more than twice a week.

PARAFFINING.

The cheeses are paraffined when they are 2 weeks old. Cheese should be paraffined to prevent the cheese from drying too much and

also to prevent molding. A convenient method for paraffining cheese on the farm is to heat the paraffin to a temperature of 240° F., in a receptacle of suitable size, then roll the cheese in the hot paraffin for about 5 or 10 seconds. The cheese is then removed and the top and bottom are dipped. The paraffin must be hot; otherwise the coat of paraffin will be so thick that it will not adhere to the surface of the cheese properly.

Great care should be taken to keep flies from the curing room. All windows should be covered with cheesecloth. Screen wire does not answer the purpose, as the fly which damages cheese by causing skippers is smaller than the ordinary house fly and can easily pass through the meshes of the screen wire commonly used.

Cheese may be cured enough to be eaten when 6 weeks old. The flavor, of course, is then quite mild.

If an even, low temperature is provided for curing the cheese it will cure slowly, and if a sharp flavor is not objectionable the cheese may be kept for many months.

FAST OR SLOW CURING CHEESE.

The manufacturing process and the temperature of curing the cheese may be modified to produce either a fast-curing or a slow-curing cheese.

The following conditions hasten the curing process:

1. A high curing temperature—70° to 80° F.
2. The development of less acid at time of salting (threads of approximately $\frac{1}{2}$ inch by the hot-iron test).
3. Using very little salt.

The following conditions retard the curing process:

1. A low curing temperature—below 60° F.
2. The development of more acid at time of salting (threads of approximately 1 inch by the hot-iron test).
3. Using a large quantity of salt.

Although the amount of acid developed influences the rate of curing, it is inadvisable to deviate from the directions given because of the danger of producing a cheese of poor quality.

SUMMARY.

1. Use clean, sweet milk for cheesemaking.
2. Heat milk to 86° F. Use a thermometer to determine the temperature.
3. Add cheese color if desired, using one-half teaspoon to 100 pounds of milk. Do not use butter color.
4. Add rennet, first diluting it with a pint of cold water. Use one-third ounce (2 teaspoons) to 100 pounds of milk. Stir rennet

in thoroughly, then leave milk and container undisturbed for 30 minutes.

5. Cut the curd when sufficiently firm. Do not crush or break it.
6. Stir the curd gently for 15 or 20 minutes.
7. Heat at the rate of 2 degrees in 5 minutes until the temperature reaches 100° F. Stir while heating.
8. Allow curd to remain in whey at 100° F. until firm and until acid enough has developed. Do not let curd mat together.
9. Sufficient acid has developed when the curd will form strings one-fourth to one-half inch long on a hot iron.
10. The curd is firm enough if a handful of it pressed together between the hands falls apart readily when the pressure is released.
11. When the curd is firm and sufficient acid has developed, draw off the whey and put the curd on a draining rack. Do not let the curd form into pieces larger than a hickory nut. Keep the curd warm while on the rack.
12. When the curd forms strings from $\frac{3}{4}$ to 1 inch long on a hot iron add salt at the rate of 3 ounces for 10 pounds of curd.
13. Have the curd at a temperature of about 85° F.; put it into a hoop, and apply pressure gently.
14. Dress cheese, return it to the press, and apply full pressure for 24 hours.
15. Place the cheese in a curing room at a temperature of between 50° and 60° F.
16. While curing turn the cheese daily for 2 weeks, then twice a week. Paraffin cheese when 2 weeks old by dipping it in paraffin heated to a temperature of 240° F.

**PUBLICATIONS OF UNITED STATES DEPARTMENT OF AGRICULTURE
RELATING TO CHEESEMAKING ON THE FARM.**

AVAILABLE FOR FREE DISTRIBUTION BY THE DEPARTMENT.

Cheese: Economical Uses in the Diet. (Farmers' Bulletin 487.)

How to Make Cottage Cheese on the Farm. (Farmers' Bulletin 850.)

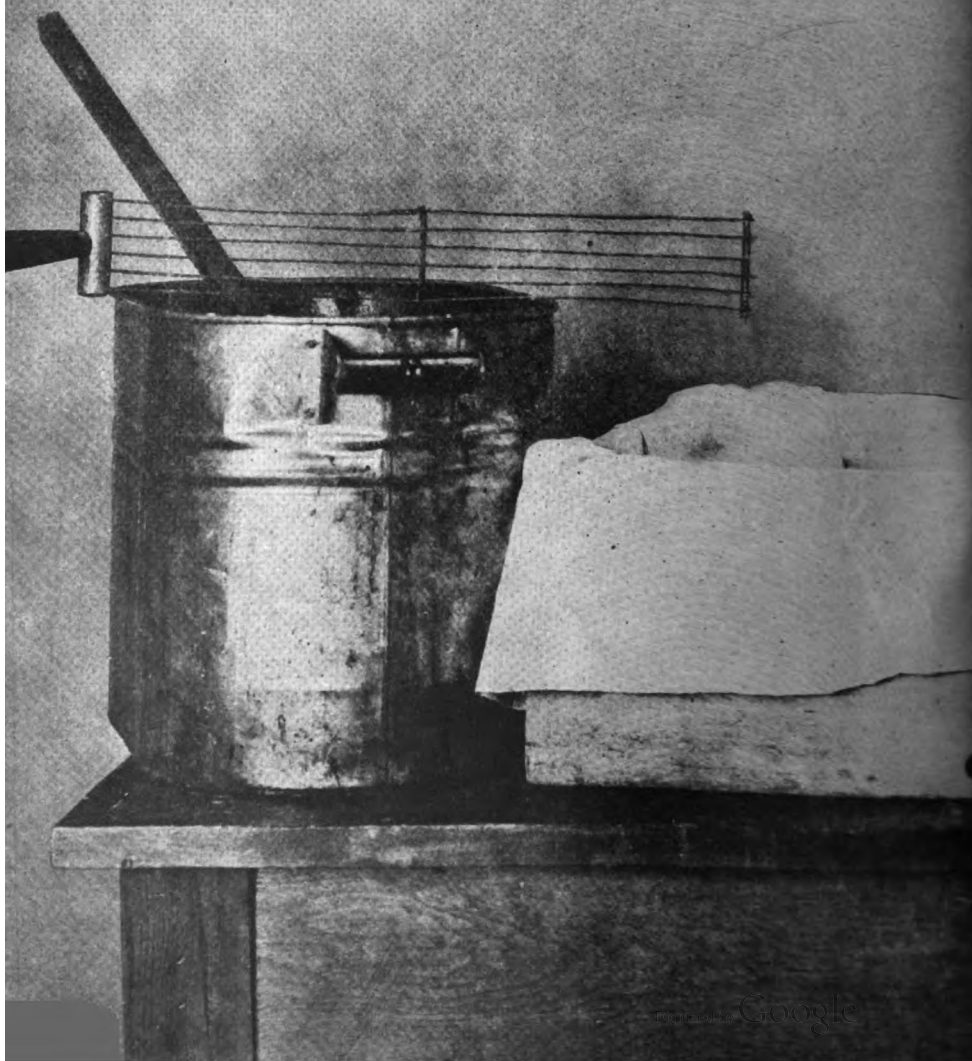
Neufchatel and Cream Cheese. (Farmers' Bulletin 960.)

Trend of the Cheese Industry in the United States and Other Countries. (Department Circular 71.)

FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, WASHINGTON, D. C.

Varieties of Cheese: Description and Analyses. (Department Bulletin 608.)
Price, 10 cents.

Factors Controlling Moisture Content of Cheese Curds. (Bureau of Animal Industry Bulletin 122.) Price, 10 cents.

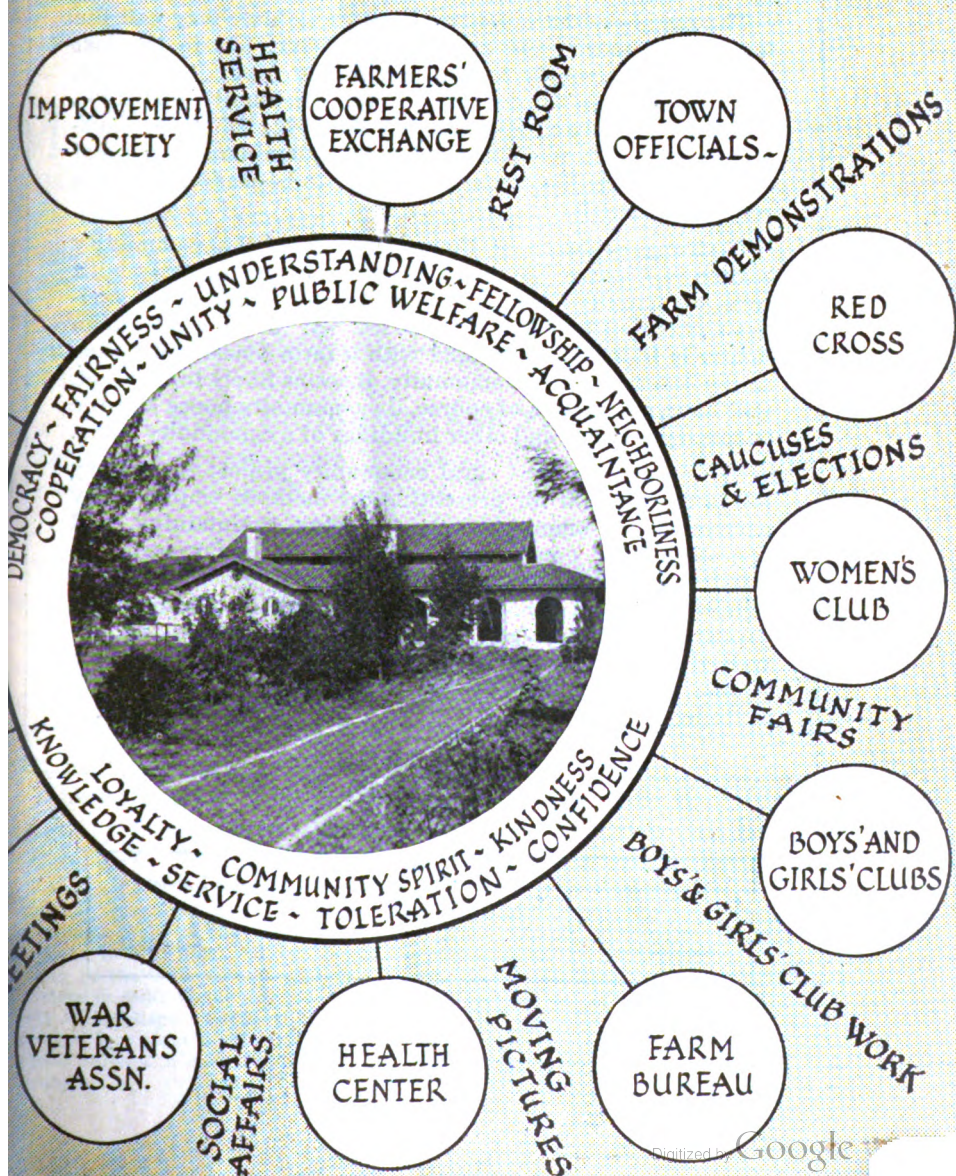


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FARMERS' BULLETIN 1192

UNITED STATES DEPARTMENT OF AGRICULTURE

ORGANIZATION OF RURAL COMMUNITY BUILDINGS



TWO WIDELY DIVERGING and competing points of view in public matters have characterized rural life in America for generations. The family point of view has led to a struggle among leading country families for family dominance, while the community point of view, tending to weld neighboring families into an undivided whole, has led to a common struggle with the forces of nature and with tradition and inertia for community control in matters that concern the common weal.

The race between these two types, which we may call the family régime and the community régime, has in the last decade gone strongly to the community type. So steady, indeed, has been the looming of the community, that now, while all the pure gold of family ideals bids fair to be carefully conserved, the spirit of family dominance in rural social life seems likely sooner or later to be merged into the community spirit.

A strong evidence of the popularity of the community régime in country life is the large number of recently built rural community houses and community buildings of various names and for various purposes. As the American farm family is indelibly associated with a farm house and home, so the American farm community, it seems likely to turn out, will have, as a matter of course, its community house and the necessary grounds and other buildings of a community home.

The newness of this rural community project in country life is the warrant for presenting the methods employed by certain rural communities in financing, maintaining, and operating their community buildings. It is far easier to build a community house than to organize a community to obtain the funds for building it, or than to guarantee its proper utilization when once built. It has been thought well, therefore, to emphasize in this bulletin the importance of the whole subject of the organization of community buildings.

C. J. GALPIN.

Contribution from the Office of Farm Management and Farm Economics

H. C. TAYLOR, Chief

Washington, D. C.

June, 1921

THE ORGANIZATION OF RURAL COMMUNITY BUILDINGS.

W. C. NASON, *Assistant in Rural Organization.*

(Section of Rural Life Studies, C. J. GALPIN, Economist, in Charge.)

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MANY TOWNS, country villages, and farm communities realize the need of a building for the whole community where general gatherings may be held, organizations meet, societies cooperate for the public benefit, recreation activities be held, public games and local dramatics be viewed, where the people may congregate socially, and where movements of a civic nature may originate. This bulletin is designed to give such communities the benefit of the experience of other communities which have already financed and built community buildings.

HOW BUILDINGS ARE FINANCED.

Such buildings are generally financed in one or more of the following ways, each of which has more or less to be said in its favor:

BY INDIVIDUAL DONATION.

In this case some person having money which he or she wishes to use for the benefit of the community provides for the erection of the building by a gift in the form of an endowment. A number of buildings have been erected in this manner and to good purpose. Such buildings are generally placed indirectly in charge of the people themselves, but actual and final control is generally placed in a self-perpetuating board nominated by the donor.

Where the community is weak financially and lacks the leadership necessary for a general financial campaign, this way may be fairly satisfactory. It is better, however, to have the community furnish

NOTE.—This is the third of a series of bulletins on rural community buildings, based on an intimate study of more than 200 of them in all parts of the country. The first, Department Bulletin 825, "Rural Community Buildings in the United States," gave the history of the movement, treated of some of the general principles involved and gave the story in detail of the erection, financing, management, and use of a few representative types of buildings. Farmers' Bulletin 1173, "Plans of Rural Community Buildings," gave the floor plans of 21 buildings of the better class, illustrating various types. The present bulletin is designed to give suggestions as to the financing and control of such buildings.

at least a part of the funds, because an endowed organization is liable to occupy a position apart from and unresponsive to the public, since it is not answerable to the public, and because people naturally take a greater interest in that in which they have invested their money.

Before a man presents a building to a community he should satisfy himself that there is need for it, that it is wanted and will be used by the community, and that it will in future years be properly maintained.

BY A LOCAL INDUSTRY.

A number of successful small-town community buildings are in operation which were financed by some local industry, such as a canning plant or sugar factory, a lumber concern or a cotton mill which wishes to do something of public benefit to the town and surrounding country which sustains it, realizing that happy and contented workers are the most efficient and loyal kind.

In such cases, if the matter is wisely handled, the concern subordinates itself as far as possible in regard to control and management. A community organization is formed, composed of dues-paying members, which is, through its duly elected officers, the apparent directing and operating force. Where possible, title itself is transferred to this organization. Employees of the concern and the other residents of the town generally have equal rights, duties, and privileges. The concern is careful so to conduct itself in relation to the building that there is no chance for the idea being formed in the minds of the people that they are being given a charity. Above all, a spirit of paternalism is avoided. Pride of possession, operation, and use by the people are encouraged.

BY CLUBS AND SOCIETIES.

In this instance some well-established social or fraternal organization, with a membership composed of a large part, often a majority, of the community, erects a building. It generally results from a union of two purposes. The society may be in need of a permanent meeting place and home of its own. The community is in need of a social center. Through the efforts of the society a building is erected which meets both needs. As a rule funds are secured by general community contributions, which, however, go into the society treasury to be paid out by it, together with the society's own money. Thus title to the building rests with the society.

Successful buildings of this character are often erected by farmers' clubs, women's clubs, athletic associations, churches, and similar organizations.

In the case of farmers' clubs and union churches, where the membership embraces practically the entire local population, the club building is a community building by virtue of the extent of the original membership. In other cases members of the community who do

not belong to the society are given the use of the building. In such an event an organization is generally formed of representatives of the society erecting the building and representatives of other societies and the unorganized people of the town. This organization controls and manages the building, the original society occupying a subordinate position except in the matter of ownership.

The success of such a building depends largely on whether or not the original society subordinates itself and occupies a position on an equality with other clubs using the building. Above all, the society owning the building must so conduct itself that it can not be accused

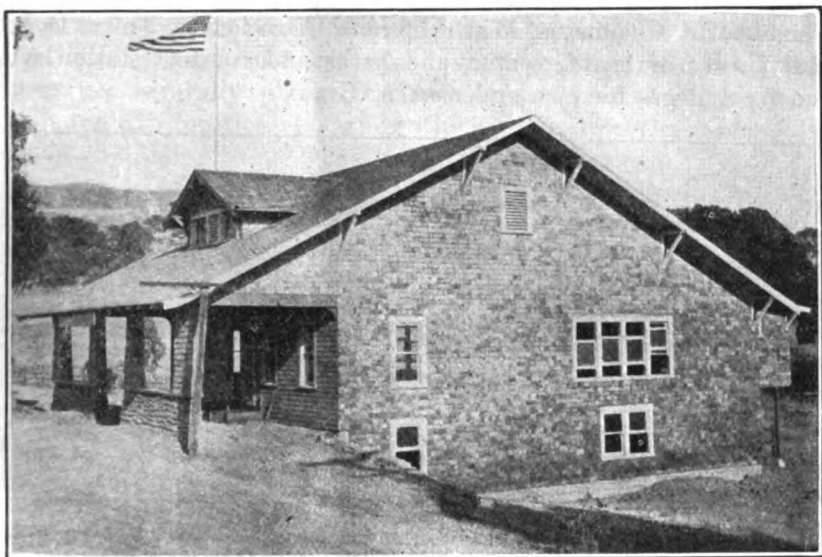


FIG. 1.- Mount George (Napa, Calif.) Farm Center building, built by voluntary contributions of money, labor, and materials.

of using the building as a means of persuading members of other societies to leave their own society to join it, or in any other way using the building for its own particular advancement.

· BY COMMUNITY ENDEAVOR.

Under this head come buildings erected through the united effort of the people and the various organizations of the community. The majority of community buildings are of this class. In such enterprises community spirit is shown at its best.

Before the cost of the building is determined the people decide, as far as possible, the kind, size, and general plan of the building desired. They consider what activities or institutions are to center in it, such as general gatherings, lectures, and sings, which necessitate an assembly hall; local dramatics, which need an equipped stage and dressing rooms; moving pictures, for which a booth and curtain

must be provided; suppers and banquets, which require an equipped kitchen and a place to dine; a library with bookcases and reading tables; a gymnasium, which may be a special room or the same room as the dining room or possibly the assembly hall if provided with movable seats; games, such as basket ball, the room for which may be used also as dining room or gymnasium; a rest room for women, especially those from rural districts; committee meetings necessitating a small separate room; a social room for men; a room for the women's club; boys' and girls' club work, for which separate rooms are needed; billiards, bowling, and such games; possibly rooms for one or more of such institutions as the County Agricultural Bureau, Chamber of Commerce, War Veterans' Association, Town Board, Red Cross; or health center, and baths and comfort station with equal privileges for men and women.



FIG. 2.—Free labor and free gravel. Laying the foundation of Mount George Farm Center building.

They carefully consider what organizations may be expected to use the building. They calculate the cost of maintaining it and arrive at an approximate estimate of the revenue that may accrue from it.

They also take into account future needs and possible expansion. They generally figure on a building that would cost a little more money than the community feels able to raise, as experience has amply demonstrated that the people working in a spirit of mutual cooperation for the public benefit can raise more money than they would naturally expect.

The ordinary methods of financing a building by community endeavor are by (1) voluntary contributions and (2) the sale of stock. These are often supplemented by the proceeds from entertainments and by loans.

In using the method of voluntary contribution a building association is formed with a clause in its constitution enabling it to col-

lect general contributions. Subscriptions are paid in the form of money, labor, or materials.

In case the funds are to be raised by sale of stock, an ordinary stock company is formed, generally incorporated. This company issues stock certificates, the total value of which equals the amount of money to be raised. These certificates are nonassessable and nondividend paying. They are generally of denominations small enough to fit the most humble purse and the number which a single buyer can secure is limited, in order that no wealthy purchaser may obtain undue power, or a small group of people secure control. Stock is often paid for in labor and materials.

The collection of contributions and sale of stock is often stimulated by "drives" such as gained vogue during the recent war. These are carefully planned. They generally come only after a campaign of education and study which emphasizes the value of the proposed building to every member of the community.

Such a campaign, at its best, is carried on without overstimulation. When successful, it results in the working out of a definite community building project with the great majority of the people in favor of it and willing to contribute toward it.

VOLUNTARY LABOR, FREE MATERIALS, ENTERTAINMENTS, LOANS.

The following table shows how certain buildings financed by community effort have been partially paid for by voluntary labor, free materials, entertainments, and loans:

Place.	Population. ¹	Cost of building.	Voluntary labor.	Free materials.	Entertainments.	Loans.
Arizona:						
Madison		\$6,200	\$300	\$50	\$850	\$2,500.
California:						
Blue Lake	507	5,000	100	50	3,190	900.
Bogue		4,300	300		400	1,500 (\$300 paid.)
Mount George		3,560	1,216		1,000	1,200 (\$300 paid).
Connecticut:						
Bolton	500	9,500	1,500	1,500		1,000.
Oiled	280	4,300				1,000 (\$800 paid).
Simsbury		1,500	350	200		
Illinois:						
Brimfield	800	29,000			\$3,740	10,000.
Iowa:						
Clinton, Lincoln town-ship		1,500			600	600 (all paid).
Dexter	761	1,360			350	
Stuart	1,826	5,000			1,000	

¹ Population here refers to the town center, if there is one. The building is also supported by the people of the adjacent rural country. Where no population is specified, the building is in the open country.

* Brimfield, Ill., raised \$3,740 for the building fund by entertainments during dedication week, Apr. 21-26, 1919, as follows:

Monday, dedication night	\$475
Tuesday, athletic night	570
Wednesday, banquet night	600
Thursday, home talent night	580
Friday, dance night	340
Saturday, bazaar night	1,175
	3,740

Place.	Popula- tion.	Cost of building.	Volun- tary labor.	Free mate- rials.	Enter- tain- ments.	Loans.
Indiana:						
Advance.....	416					\$1,500 (\$700 paid).
Darlington.....	1,000	\$2,800	\$800			400 (\$100 paid).
Newmarket.....	334	5,200				1,500.
Rossville.....	677	2,700	200	\$200	\$800	500.
Kansas:						
Geneva.....	100	3,000	700			700 (\$200 paid).
Potwin.....	249	6,141	370	245	1,502	1,000.
Russell.....	1,900	3,000	All.		400	
Massachusetts:						
Holden.....	2,100	4,500				1,500 (\$500 paid).
Millington.....	250	4,200			1,200	
Maine:						
Seal Harbor.....	250	17,000				7,000 (\$4,000 paid).
Michigan:						
Centerville.....	613	13,500			400	7,000.
Minnesota:						
Eden Township.....		4,644	1,000			1,300 (\$700 paid).
Hendrum.....	355	6,925			300	1,500 (\$300 paid).
Minnewashta.....		2,140	650	100	234	800 (all paid).
Northome.....		800	150	530	120	
Red River township.....		2,500	650		625	
Scandia.....		2,550			1,000	
Missouri:						
Atlanta.....		3,300	500	500	300	1,150.
Montana:						
Fairfield.....		6,100			1,000	2,600.
Menard.....		3,060	300			1,200.
Plentywood.....		2,596	300		1,500	
Willard.....		1,600	400			
New Hampshire:						
Meredith Neck.....	100	5,600	1,000	500		2,000.
New York:						
Locust Valley.....	530	32,000	1,500			
Suffern, R. F. D.....		10,262				2,950 (all paid).
Ohio:						
Mad River.....		3,300	200			2,100 (\$1,800 paid).
Oklahoma:						
Sooner.....		2,200	450	115	600	
Oregon:						
Garfield.....		1,500	400	200	400	500 (\$200 paid).
George.....		1,250	600		100	
Plymouth.....		2,557	600	300	92	100.
Texas:						
Perry.....		1,400	500		240	460.
Tennessee:						
West Union.....		b 2,000	(c)	(d)		
Woodstock.....		b 1,800	(c)	(d)		
Utah:						
Hyrum.....	1,833	21,000				9,100 (\$3,000 paid).
Timpanogas.....		5,100	2,000	300	200	
Wisconsin:						
Fairfield.....		2,700	500	100	200	
Nashotah.....	250	4,800	500		300	1,500 (\$1,000 paid).
Virginia:						
Carrolton.....		1,500	50	50	400	900 (\$300 paid).
Carrsville.....	270	1,700			1,500	

b Value.

c All reconstruction.

d All furnishings.

Many buildings erected through club financing, especially separate church community buildings, have been financed to a considerable extent by voluntary labor and entertainments. Thus the township community hall of Northern Township, Beltrami County, Minn., which cost \$3,500, was financed by township funds, \$2,000, and \$1,500 from the Northern Farmers' Club, including voluntary labor \$500, entertainments \$500, and equipment \$500.

The Geneva Township building at Como, Wis., costing \$5,880, and financed from township funds, was aided by \$700 from the Farmers' Club, which was raised by entertainments.

The People's Hall, at Honey Creek, Wis., which was financed by the only church in the neighborhood, through widely distributed general contributions, was aided by \$1,000 from entertainments.

The Sooner Union Church and community building, in the open country in Oklahoma, which cost \$2,200, was aided by \$800 from entertainments.

Nearly all loans reported in this connection were contracted in very recent years and run from 20 to 30 years. Interest is generally from 6 to 7 per cent.



FIG. 3.—Mount George Farm Center building in course of construction. Farmers doing carpenter work on their own building.

ADVANTAGES OF THE COMMUNITY METHOD OF FINANCING COMMUNITY BUILDINGS.

(1) People are devoted to that to which they voluntarily subscribe.
(2) This method develops community cooperation, promotes union, and decreases local antagonisms through the necessity of different organizations and factions working together in a financial campaign.

(3) As the money is voluntarily given from private funds the people are enabled to make experiments in building which they would hesitate to make with public funds or those of an individual or club.

(4) Those who pay control. Only a high type of citizenship subscribes to an institution of this kind. Thus public spirit at its best is in control. The influence of politics, which enters into the control of public institutions, is at a minimum.

Financing a building by general voluntary contributions is perhaps the simplest, quickest, and most elastic way. Incorporated stock associations furnish more of the elements of financial permanency, and appeal to many buyers of stock through the sense of ownership which stock gives and the fact that it is negotiable.

BY THE LOCAL GOVERNMENT.

In recent years the idea has more and more prevailed that it is as logical for a government to erect buildings through taxation for the



FIG. 4.—Annual May Day fete, community house, Kentfield, Calif.

social and recreational needs of its citizens as for the needs of government, education, or health. A number of very successful buildings of this class have been erected, mostly by township governments, where they furnish a strong appeal to the farming classes.

The question is submitted to the people by vote as to whether they desire to tax themselves for such structures, which, if thus authorized, are financed by money already in the treasury, by special taxes, or the issue of bonds.

ADVANTAGES OF THE LOCAL GOVERNMENT METHOD OF FINANCING COMMUNITY BUILDINGS.

(1) Title and control rest with an established continuous organization—the government. This gives the building the advantage of

a degree of permanency that it could not have under private or quasi-public control. It enables the association to proceed with the work connected with the building without undue worry as to the future of the building itself.

(2) The building is financed and maintained as other public works and edifices, by the usual method of paying taxes. Thus distributed over a long period of years, the individual financial support given is felt much less than when the person is called upon to pay a large contribution at a single or a few separate times.

(3) A community building supported by public taxation is democratic in nature. All citizens are received on a basis of equality. Character and intelligence determine a man's standing in the movement rather than the size of his subscription.

HOW THE UPKEEP OF BUILDINGS IS FINANCED.

In the case of buildings financed by an individual or by an industrial concern a community association is generally formed which guarantees the maintenance of the building as a condition of the donation. Sometimes this is done by the municipal government. If this is not done, the donor generally includes a perpetual maintenance fund in the original endowment. In the case of community buildings financed by clubs, the club stands back of the building as a guaranty of its maintenance. The local government is behind all buildings which it finances, although revenue accruing from the building is generally sufficient for all maintenance expenses.

RECEIPTS.

Expenses are met by dues, fees, rentals, and receipts from entertainments, profits, and concessions. Some buildings are maintained entirely by annual dues. Some of the more highly organized ones sell concessions for the sale of candy, fruit, etc., but most buildings are maintained by returns from entertainments and rentals. Organizations of a public-benefit nature use the building free, while others pay a small maintenance rental. Entertainments given for profit pay a higher rent.

EXPENDITURES.

These are generally for heat, light, taxes, insurance, and caretaker for the simpler buildings, to which are added secretary, physical director, or librarian for the more elaborate ones. Such expenses range from 5 to 10 per cent of the original cost of the building each year.

The following table shows the amounts received from entertainments and rentals by a number of representative buildings in a given year:

Place.	Total expenditures.	Receipts.		Place.	Total expenditures.	Receipts.	
		Entertainments.	Rentals.			Entertainments.	Rentals.
California:				Minnesota:			
Bogue.....	\$201	\$101	\$100	Hendrum.....	\$745	\$340	\$750
Blue Lake.....	189		200	Minnewashta.....	800	300	
Connecticut:				Northfield.....	2,400		1,000
Bolton.....		All.		Massachusetts:			
Gilead.....	450	250	200	Holden.....	425		425
Illinois:				Greendale.....	1,211		882
Brimfield.....	2,400	1,400	1,000	Missouri:			
McLean.....	500	100	400	Fenton.....	600	600	
Indiana:				Montana:			
Advance.....	250		1,000	Fairfield.....	250		225
Darlington.....	210	210		Orchard Homes.....	344	336	
New Market.....	280		325	Ohio:			
Iowa:				Mad River.....	325	400	
Dexter.....	190	50	190	New York:			
Kansas:				Loudonville.....	449	200	127
Geneva.....	132		136	Utah:			
Russell.....	400	400		Hyrum.....	400		400
Michigan:							
Centreville.....	600	300	300				

Buildings financed by individual donation, by industrial concerns, by clubs, or by local governments, are largely maintained in the same way as those financed by community effort.

HOW THE CONTROL OF BUILDINGS IS ORGANIZED.

The form of organization best adapted to the control and maintenance of a community building should receive careful consideration. In some instances money has been wasted and time and energy ill-spent on the erection of buildings with laudable purposes back of them, but without efficient organizations to control and administer them.

BUILDINGS FINANCED BY AN INDIVIDUAL.

Title.—In most cases title remains with the donor or his heirs. This keeps the property in the family if it should, in time, cease to function as intended. Sometimes the donor turns the title over to the municipality or other governmental unit which agrees properly to safeguard and care for it. This insures the property being used for some public purpose even though its original use terminate. In other cases the donor gives the title to a well-established organizations, such as the chamber of commerce or a church. Thus some permanent, public-spirited organization is always in control. Less frequently it is turned over to a community association formed especially to administer it. In this case it is controlled by an organization in entire sympathy with its aims.

Membership.—Frequently membership is open without restriction to every member of the community. This is generally the case when the maintenance of the building has been perpetually provided for by the donor. When the building is turned over to a specially-organized community body which finances it, the membership is often confined to dues-paying members, thus including all who desire to contribute.

Control.—Control is generally exercised by a self-perpetuating board of trustees appointed by the donor. If title is with the mu-

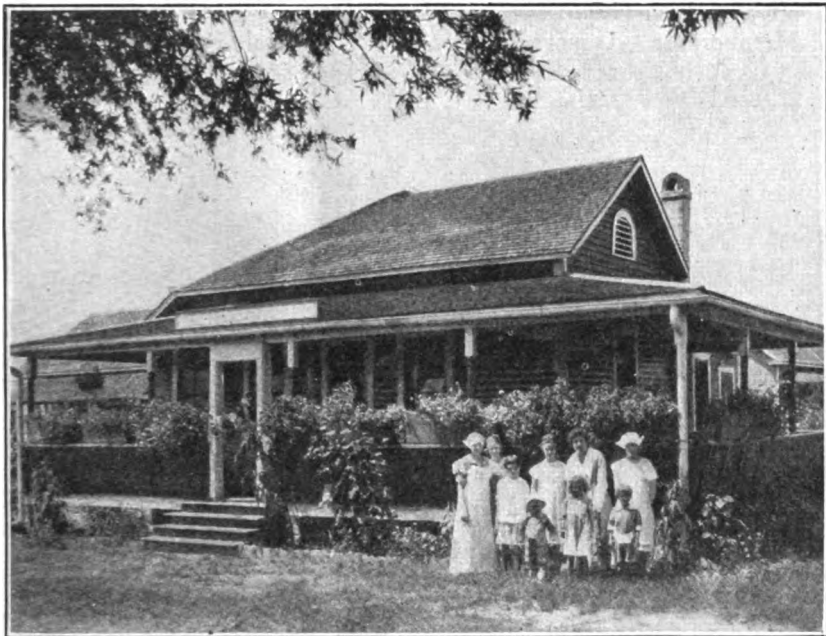


FIG. 5.—Club house for girls, built by an industrial concern at Tupelo, Miss.

nicipality the building is controlled by the usual public officials. If title is with a private organization control rests with it.

Management.—The trustees appointed by the donor nominate a manager, secretary, or director. The boards of trustees of other institutions controlling the building do likewise. In some cases a house committee takes the place of a manager or secretary.

Scope of use.—If there are no strings attached to the gift it is available for all nonpolitical, nonsectarian, nonfactional uses which are for the public benefit.

BUILDINGS FINANCED BY AN INDUSTRIAL CONCERN.

Title.—Similar to that of individual financing.

Membership.—Similar to that of individual financing. Sometimes the concern's employees are given special consideration.

Control.—Either by the concern itself or by methods similar to individually donated buildings. Sometimes the board of control consists of representatives of the concern and of the private organization.

Management.—Similar to that of donated buildings.

Scope of use.—Similar to that of donated buildings. Sometimes the employees of the concern are furnished special privileges by the concern in the shape of baths, pool, lockers, gymnasium, or a library.

BUILDINGS FINANCED BY A CLUB.

Title.—With club.

Membership.—Generally open to every member of the community who pays the required annual dues of the community association.



FIG. 6.—Girls' club house, Tupelo, Miss. The canning club at work.

Control.—To all intents and purposes with the community association; ultimately where the title rests. Sometimes there is a board of directors composed of representatives of the club and of other organizations.

Management.—Sometimes a secretary or house committee appointed by the original society, more frequently appointed by the joint board.

Scope of use.—This varies from the restricted kind, in which the club reserves the major use to itself, to the unlimited kind in which the club is practically on an equality with all other organizations as to use.

BUILDINGS FINANCED BY VOLUNTARY COMMUNITY EFFORT.

Title.—With the association which financed the building or its elected trustees. The association is generally incorporated to enable it to acquire and own property more readily.

Membership.—There are generally two classes: (1) Regular members or those who helped finance the building, and (2) social members who pay dues in order to help maintain the building, and who are allowed common use of it.

Control.—With slight variations of form, control, as a rule, rests with the association which financed the building. This control is exerted through a board of directors elected by the association mem-



FIG. 7.—Interior view of girls' club house, Tupelo, Miss.

bership. This board, or the association, elects, generally from the board membership, the other usual officers.

Scope of use.—All the people of the community are encouraged to become social members if not original financing members.

BUILDINGS FINANCED BY LOCAL GOVERNMENT.

Title.—Rests with the government which finances it.

Membership.—Includes all citizens of the governmental unit.

Control.—By the local government.

Management.—By a regular official of the government or by its appointed representative.

Scope of use.—This is generally determined by the limitations that apply to other local buildings of a public nature.

ARTICLES OF INCORPORATION, CONSTITUTIONS, AND BY-LAWS.

Most community associations which finance their buildings by issuing stock incorporate under the State laws in order that they may have a more effective instrument for buying, selling, and holding property. The manner of incorporating and the forms used are much the same in each State, and information regarding it may be secured from the proper officials in the various States. The constitution of an association of this character is more important than the constitutions of most local societies. Besides such ordinary information as the election and duties of officers, it often treats of more complex matters, such as the election, duties and powers of

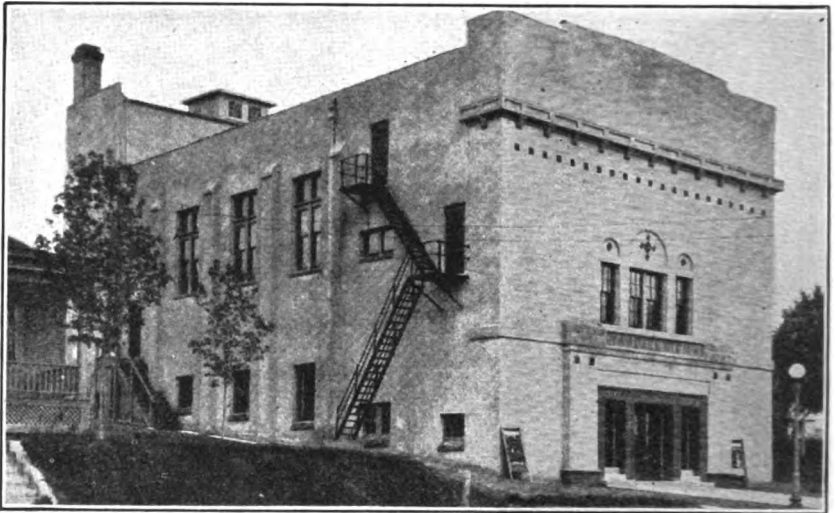


FIG. 8.—Community hall, St. Croix, Wis., financed by local taxation. Building contains an auditorium, with stage and dressing rooms, a dining room, kitchen, rest room, and offices for the village officials.

trustees, the relationship existing between the incorporated financing body and the social membership, the basis of control, voting units, etc. As these local community associations are of comparatively recent growth and possess the germ of so much possible good, the constitutions are, in reality, the charters of the movement and are generally well expressed and defined. Such documents should be as short, simple, and direct as it is possible to make them. The best of them include only what is necessary to make clear the work to be done, the manner of doing it, and who is to do it.

A constitution suitable for one association might not be fitted for another. For that reason no "model" constitution is here presented. However, a few entire constitutions, and excerpts from

others, as adopted by associations in actual operation, are given us illustrative of the different forms suitable for different conditions. The community may make its own constitution and by-laws, acting through its committee, who may study these different forms and others that they may secure and work out a constitution, readily agreed upon and understood by the membership and fitted to local conditions.

It is well to remember, however, that the constitution alone can not assure success. No matter how long-studied and how well-drafted the constitution of an association may be, that association will fail if it does not have high aims, is not founded on correct principles, and is not conducted in a spirit of mutual helpfulness and cooperation.

The following constitutions and by-laws are the forms used in the organization and government of certain community buildings in actual operation. In some of them only those excerpts are given that present unique ideas of organization, the customary articles being omitted. These various forms are offered only as suggestions.

BUILDINGS ERECTED THROUGH SALE OF STOCK.

Holden, Mass.—All the forms used in the organization and government of this successful community building are here given in the hope that they will be helpful to other communities contemplating the erection of similar community buildings. This building is in a town of 2,147 inhabitants.

TEMPORARY ORGANIZATION.

We, the undersigned, on this eighteenth day of May, nineteen hundred and fourteen, do hereby declare ourselves a temporary organization with the purpose of promoting the social welfare of this community; in furtherance of this end, under the name of the Community Club of Holden, Massachusetts, to purchase and devote to such purposes as may be later determined as worthy, a certain piece of property in Holden, Massachusetts, known as the ——— estate.

PUBLIC ANNOUNCEMENT.

On May 11th, 1914, at the home of ———, there was formed a temporary organization under the name of the Holden Community-House Association.

The officers elected were: President, ———; secretary, ———; treasurer, ———.

The object of the association is to secure and to maintain a gathering place for the various social organizations of the community. There is a special need for permanent quarters for the Boy Scouts, also the Camp Fire Girls. An option until June 1st has been secured on the valuable property known as the ——— estate, at the corner of ——— and ——— Streets, Holden Centre. The purchase price is to be \$4,000. There is a bank mortgage of \$2,900 on the property. An immediate cash outlay of about \$2,500 will be required to complete the purchase and to put the property in good condition for year-round occupancy and to so remodel the interior as to provide two large assembly rooms on the first floor, four large rooms on the second floor, install new plumbing and heating systems, etc.

It is also planned to remove the barn, sheds, etc., and to improve the grounds.

Careful estimates have been made of expenses to be incurred and of the income expected. These estimates make it apparent that the project is feasible and will be self-supporting.

The requisites for success are public interest and financial support, and in the belief that these are not wanting in Holden, the undersigned committee of three was appointed to solicit pledges from those interested. Shares of ownership are to be offered at \$5.00 each, one-half payable upon delivery of certificate and one-half within thirty days.

The prime object of this enterprise is to secure against unwise and unattractive uses an important piece of property, and to insure keeping intact a group of four fine old buildings, making a most attractive town center.

It is hoped the response to this circular will be immediate and general.

A meeting of subscribers will be held at a date and place to be announced later to effect a permanent organization.

Please sign the enclosed application, stating the number of shares at \$5.00 each which you wish to subscribe for, and hand to any member of committee or mail to the chairman.

COMMITTEE.

COPY OF THE CHARTER.

THE COMMONWEALTH OF MASSACHUSETTS.

Be it known that whereas (names:) — have associated themselves with the intention of forming a corporation under the name of Holden Community Corporation for the purpose of the following: To acquire, hold, manage, develop, improve, lease, mortgage, buy, or sell real estate situated in [the] town of Holden. The duration of the corporation shall be for the term of fifty years; with a capital stock of ten thousand dollars, common stock. Par value, five dollars. The amount of the capital stock now to be issued is four hundred and twenty-two shares, to be paid for as follows: In cash in full, four hundred and twenty-two shares; and have complied with the provisions of the statutes of this Commonwealth in such case made and provided as appears from the articles of organization of said corporation, duly approved by the commissioner of corporations and recorded in this office.

Now, therefore, I, —, secretary of the Commonwealth of Massachusetts, do hereby certify that said (names:) —, their associates and successors, are hereby organized and established as, and are hereby made, an existing corporation under the name of Holden Community Corporation, with the powers, rights, and privileges, and subject to the limitations, duties, and restrictions which by law appertain thereto.

Witness my official signature hereunto subscribed and the Great Seal of the Commonwealth of Massachusetts hereunto affixed, this thirtieth day of June, in the year of our Lord one thousand nine hundred and fourteen.

(Signed) _____,

Secretary of the Commonwealth.

BY-LAWS.

ARTICLE 1.

The name of this corporation shall be Holden Community Corporation. It shall have a corporate seal bearing the name of the corporation and such other device or inscription as the board of directors may determine.

ARTICLE 2.

The officers of this corporation shall be a board of directors consisting of seven (7) stockholders, a president, a clerk, and a treasurer, all of whom excepting the president shall be chosen by ballot annually at the first meeting of the corporation and at each annual meeting thereafter, and one of said board of directors shall be chosen president by the said directors, and all said officers shall hold their offices until others are chosen and qualified in their stead. If any director ceases to be a stockholder his said office becomes vacant. Vacancies in any of said offices may be filled at a special meeting of the stockholders.

ARTICLE 3.

The directors shall have general direction, control, and management of the property and business of the corporation. They shall have power to purchase and lease, pledge, and sell all such personal property and to make all such contracts and agreements in behalf of the corporation as they may deem needful or convenient for the prosecution of its business and operations.

ARTICLE 4.

The president shall preside at all meetings of the stockholders and of the directors and shall, with the treasurer, sign all certificates of stock issued by the corporation.

ARTICLE 5.

The clerk shall be sworn each year to the faithful discharge of his duties and a record of the oath with the evidence thereof shall be made by him upon the records of the corporation. He shall attend the meetings of the stockholders and of the directors, and shall make record upon the book of records of the corporation of the proceedings of the stockholders and of the board of directors at their respective meetings. He shall have custody of the certificate and transfer books and stock ledger of the corporation, and shall record all transfers of shares in the corporation. He shall notify the stockholders and directors of their respective meetings in accordance with the by-laws of the corporation.

ARTICLE 6.—TREASURER.

The treasurer shall have the custody of all monies, obligations, contracts, documents, etc., belonging to the corporation, and of its common seal. He shall collect all monies from time to time due the corporation and disburse the same pursuant to the order of its board of directors or of its stockholders. Together with the president, he shall sign all certificates of stock issued by the corporation. The treasurer shall have the sole right to make, sign, endorse, and accept for and in the name of the corporation promissory notes and checks, and then only in the regular course of its business. He shall execute and deliver in behalf of the corporation all such instruments under its common seal as may be ordered by the stockholders or directors unless their execution and delivery is otherwise provided for by vote and shall affix the common seal to all certificates of stock issued by the corporation, and shall perform such other duties as the directors may require.

ARTICLE 7.—MEETINGS OF THE DIRECTORS.

Meetings of the directors may be called by the president or treasurer or any director; and the clerk shall notify the directors of such meeting whenever requested in writing by the president, treasurer, or director calling such meeting. A notice in writing mailed forty-eight hours before the meeting shall be sufficient notice of the meeting.

ARTICLE 8.

Notice of all meetings, annual and special, of the stockholders shall be given to each stockholder by mailing the same addressed to him seven days at least before the time of such meeting.

ARTICLE 9.

At any meeting of the stockholders the stockholders having the majority of the shares of the capital stock represented in person or by proxy, shall constitute a quorum for the transaction of business. At any meeting of the board of directors five directors shall constitute a quorum.

ARTICLE 10.—STOCKHOLDERS' MEETING.

An annual meeting of the stockholders shall be held on the first Monday of January at 8 o'clock p. m. at Community House. The fiscal year of the corporation shall end with December thirty-first of each year. Special meetings of the stockholders may be called by the president or by a majority of the directors, and may be called by the clerk on written application of three or more stockholders who are entitled to vote, stating the time, place, and purpose of the meeting.

ARTICLE 11.—VOTES AND PROXIES.

At all meetings of the stockholders each stockholder shall be entitled to one vote for each share of stock held by him, and absent stockholders may vote and be represented by their lawfully constituted proxies.

ARTICLE 12.—CERTIFICATES.

All certificates of shares of the capital stock of the corporation shall be numbered progressively from the first and shall be signed by the president and treasurer and bear the seal of the corporation and shall set forth the names and residences of the respective stockholders.

ARTICLE 13.—TRANSFER OF STOCK.

All shares of stock of the association shall be transferable only on the books of the company by the holder thereof in person, or by attorney duly authorized in writing, and upon the surrender and cancellation of the certificates therefor duly endorsed.

ARTICLE 14.—ALTERATION OF BY-LAWS.

Any of these by-laws may be amended, repealed, or changed by a vote of the stockholders holding a majority of the shares of the capital stock of said corporation represented in person or by proxy at any annual or special meeting of the stockholders. In the notice of such special meeting it shall be stated that the amendment, repeal, or change of the by-laws may be acted upon.

AMENDMENT 1.

Article 2 to read as follows:

The officers of this corporation shall be a board of directors consisting of nine (9) stockholders, two of whom shall be the clerk and the treasurer of the corporation, a president, a clerk, and a treasurer, all of whom, excepting the president shall be chosen by ballot annually at the first meeting of the corporation and at each annual meeting thereafter, and one of said board of directors shall be chosen president by said directors, and all said officers shall

hold their offices until others are chosen and qualified in their stead. If any director ceases to be a stockholder, his said office becomes vacant. Vacancies in any of said offices may be filled at a special meeting of the stockholders.

Elgin, Nebraska.—A feature of this constitution worthy of note is the provision for a double organization, i. e., the social organization within the business organization or "a wheel within a wheel," as it has been called. The corporation is managed by the board of directors elected at the annual meeting of the stockholders. They employ a commissioner to look after the social organization which the club maintains and which is supposed to be the clearing house for all the social activities of the village. This building was erected in a village of 900 inhabitants.

ARTICLES OF INCORPORATION OF THE ELGIN COMMUNITY CLUB.

ARTICLE I.—NAME.

The name of this corporation shall be the "Elgin Community Club."

ARTICLE II.—OBJECT.

The objects for which this company is formed and the powers which it shall exercise are * * * ; to erect, construct, equip, operate, manage, and maintain a community club house and club rooms for recreation and amusements; * * * to sell social-club memberships to nonstockholders, which members shall be entitled to all the privileges of the club, except the right to participate in the control of its corporate affairs; * * *.

* * * * *

ARTICLE V.—CORPORATE STOCK.

SEC. 1. The amount of capital stock of said corporation shall be \$25,000.00.

SEC. 2. The capital stock shall consist of 250 shares of \$100.00 each, and the amount of the capital stock with which the said corporation shall begin business shall not be less than \$7,500.00; and the corporation may collect unpaid installments on subscription of said capital stock by giving ten days' notice to such subscriber.

ARTICLE VI.—BOARD OF DIRECTORS.

The number of directors shall be seven. The directors shall manage the business of the company, elect all officers of the company, and do each and everything necessary and proper for the carrying out of the objects herein expressed. The directors shall be elected at the annual meeting of the stockholders; but vacancies existing at any other time may be filled by the board itself, or, in default of a quorum, by special meeting of the stockholders. The officers of the corporation shall be elected at the meeting of the board of directors immediately following the annual election.

* * * * *

ARTICLE IX.—VOTING.

At all meetings of the stockholders of this company, each stockholder shall be entitled to 1 vote for each share of stock by him owned, which vote may be cast in person or by proxy. All officers shall be elected by ballot.

* * * * *

ARTICLE XII.—FIRST BOARD OF DIRECTORS.

Immediately after the capital stock of the company has been subscribed to the amount of not less than \$7,500, the incorporators herein named shall call a meeting of all subscribers to its capital stock, and said stockholders shall proceed to elect a board of directors, who shall serve until the annual meeting in January, 1917, and until their successors are elected. All other boards of directors except the first shall hold office for one year.

* * * * *

CORPORATION BY-LAWS.

ARTICLE 1.—PROPERTY.

(a) The real estate and fixed property of the corporation is hereby declared to be all the real estate which it may have at any time in its possession by virtue of purchase, lease, gift, or other manner of acquirement, and is subject at all times to the control of the board of directors which is elected by the holders of the capital stock.

(b) The merchandise of the corporation is hereby declared to be: The rights and privileges of social membership, the use and comforts of the various real and personal properties of the corporation, including its auditoria, parks, etc., subject to the house and grounds rules as they may be in force from time to time.

ARTICLE 2.—POWER OF DIRECTORS.

The corporation, through its directorate, shall make all regulations for use of the various properties, fix fees and regulations for social memberships, rentals, admission charges for exhibitions, etc., fees for games, bath, and other privileges.

ARTICLE 3.—RIGHTS OF STOCKHOLDERS.

Holders of the capital stock shall have all the rights enumerated in the articles of the corporation as to the real estate and financial control of the property interests, but shall not be entitled to the privileges of social membership, nor participation in the meetings of the social organization unless they shall qualify for the same by paying the same annual membership fee, in advance, as shall be prescribed for social members of the class to which they may be eligible.

ARTICLE 4.—THE SOCIAL ORGANIZATION.

The corporation shall maintain the social organization known as the Elgin Community Club, subject to the rules and regulations prescribed under the section headed "The Social Organization."

* * * * *

ARTICLE 10.—ADVISORY BOARD.

The members of the village board of trustees, the pastors of the various churches, the superintendent of public education, and the village marshal, provided they maintain membership in the club, shall constitute an advisory board which may meet from time to time with the board of directors in consideration of the various interests of the community.

* * * * *

THE SOCIAL ORGANIZATION BY-LAWS.

ARTICLE 1.—POWERS AND OBJECT.

(a) The word "club" in this section shall be construed to mean the social organization as distinguished from the corporation.

(b) The social organization of the Elgin Community Club shall entitle its members to all the rights and privileges of the club, except those reserved in the articles of incorporation to the stockholders; subject to the by-laws in force and as they may be added to or amended from time to time. The club is organized for the promotion in all ways possible of the welfare, industrial, and social development, commercial, agricultural, and general public interests of the community of and adjacent to Elgin, Nebraska.

* * * * *

ARTICLE 2.—OFFICERS.

The president and vice president of the corporation shall preside in order at the meetings of the social organization. The commissioner shall be secretary thereof and perform all duties necessary to his office. In his absence the secretary of the corporation shall serve, when neither are present the president shall appoint a secretary pro tem. The corporation treasurer shall be treasurer thereof and shall keep separate the corporation and club funds.

* * * * *

ARTICLE 3.—MEMBERSHIP.

(a) Regular. Any person of legal age, of good character and standing, who is a resident of any of the following townships * * * ; may become a member in the regular class upon application signed by himself and bearing the recommendation of two members in good standing and receiving the approval of not less than two-thirds of the board of directors, said approval to be determined by ballot; application must be accompanied by initiation fee. * * *

(b) Special: Traveling men and nonresidents.

(c) Boys.

ARTICLE 4.—FEES AND DUES.

Until January 1, 1917, the initiation fee shall be 25 cents and the dues shall be at the rate of fifty cents per month payable in advance for the number of months remaining from date of application till January 1, 1917. On and after January 1, 1917, the initiation fee shall be five dollars for all persons in the regular class and twenty-five cents for all in special class and boys.

Dues for the regular classes shall be as follows: Family membership, \$15.00 per annum. Payable in advance. Single man's membership, \$12.00 per annum payable in advance. For special classes: Boys under 21 years, \$5.00. Payable in advance. Nonresidents, \$5.00 per annum.

* * * * *

ARTICLE 6.—PRIVILEGES.

The corporation shall furnish, in consideration of the annual membership fee, a comfortable meeting place for the club at its regular monthly and special meetings. It shall maintain and keep comfortable the reading rooms, gymnasia, recreation and ladies' rest room, etc., for the daily use of club members and their guests. * * *

ARTICLE 7.—CLUB FUNDS.

The club may raise funds for its special uses by subscription, solicitation, entertainments, or in any manner not conflicting with the by-laws or State statutes for the several objects of its organization; which funds shall be kept separate from the corporation funds by the treasurer and administered by him in accordance with the action of the club upon warrant signed by the commissioner.

The club shall have no authority to make any contract involving the corporation treasury, unless by consent of the board of directors, but shall at all times have its special funds under its own control. The right to disapprove and set aside any action of the club shall always be vested in the board of directors, and in the event of the dissolution of the club or failure to maintain interest, all the property of the club shall automatically revert to the corporation.

* * * * *

HOUSE AND GROUND RULES.

ARTICLE 1.—DUTIES AND POWERS OF COMMISSIONER.

It shall be the duty of the commissioner to act as manager of the auditorium and have general oversight of the building and grounds. He shall act as secretary of the social organization, conduct the correspondence, collect dues and subscriptions for various purposes as they may be authorized from time to time, and do such other work as may be ordered by the board of directors, to which he shall at all times be responsible. All the assistants in the building or grounds shall at all times be under his direction and subject to his discipline. * * *

He shall have power at all times to administer the discipline of the club and to exact obedience to its rules. * * *

* * * * *

ARTICLE 3.—AUDITORIUM AND HALL LEASES AND CONTRACTS.

Every contract made for the use of the auditorium shall contain in heavy type at the head of the blank the following words: "READ YOUR CONTRACT! You know your company and production and if you do not wish to comply with our house regulations do not sign it. We guarantee you a square deal, but we insist upon quality and the maintenance of the standard of the house." And in the body of the contract shall be the following words: "The commissioner shall have absolute authority, with or without the consultation of the advisory board or board of directors, any time that he deems it advisable, to ring down the curtain upon any performance or terminate the engagement of the auditorium and order the repayment of the admission fee to the members of the audience, when he shall be convinced that the performance or use of the building is destructive of morality, is obscene or profane, or is offensive to the higher development of the community, or shows a lack of quality necessary to the standards of the house. In the event of any such action any advance rentals which may have been paid shall be forfeited to the corporation treasury to cover the cost of light, heat, service, etc. * * *

Dexter, Iowa.—This building was erected in 1915 in a town of 767 population at a cost of \$13,000.

ARTICLES OF INCORPORATION.

ARTICLE I.

The name of this corporation shall be The Community House Association of Dexter, Iowa.

ARTICLE II.

The object of this corporation shall be the development and promotion of the social, moral, religious, athletic, and educational interests and activities of the town of Dexter, Iowa, and vicinity.

ARTICLE III.

The amount of capital stock authorized is ten thousand and no/100 (\$10,000.00) dollars, and shall be divided into shares of five and no/100 (\$.00) dollars, each, and shall be fully paid and nonassessable. Not more than twenty (20) shares of stock shall be sold to or held by any one person at any one time.

ARTICLE IV.

The affairs of this corporation shall be managed by a board of managers consisting of seven (7) members, four (4) of whom shall be elected from the office bearers of the churches of Dexter, Iowa, existing at the date of this incorporation, with not more than two (2) of such members from any one church, one (1) from the school board of the independent school district of Dexter, Iowa, one (1) from the town council of Dexter, Iowa, and one (1) from the farmer's short course of Dexter, Iowa, or any successor to it which represents the farming interests of this community; and said board shall organize itself by the election of a president, vice president, and a secretary-treasurer from its own number, and such other officers, including an executive committee, as they may see fit or as may be provided by the by-laws of this corporation.

* * * * *
Barnard, S. Dak.—Following is the constitution of the Barnard Community Center Association, of Barnard S. Dak.:

ARTICLE 1.—NAME.

The name of this organization shall be "Barnard Community Center Association."

ARTICLE 2.—OBJECT.

The object of this company shall be to erect and maintain a hall suitable for the needs and welfare of the community.

ARTICLE 3.—CAPITAL.

The authorized capital of this company shall be seven thousand dollars (\$7,000), divided into shares of the par value of twenty-five dollars (\$25) each.

ARTICLE 4.—OFFICERS.

The officers of this company shall be a board of three directors, who shall be the president, vice president, and the secretary-treasurer.

ARTICLE 5.—AMENDMENTS.

This constitution may be amended by a two-thirds vote of the stockholders present at any regularly called meeting.

ARTICLE 6.—QUORUM.

Two members of the board of directors shall constitute a quorum and may transact any business that may properly come before them.

BY-LAWS.

SEC. 1. Each director shall be elected by a majority vote of the stockholders present at the annual meeting, one director to be elected each year and to hold office three years or until his successor has been elected.

SEC. 2. The annual meeting of the stockholders shall be held on the third Saturday in March. A special meeting may be called by the president or by the secretary-treasurer by giving at least seven days' written notice thereof. Each stockholder shall be entitled to one vote at such regular or special meetings.

SEC. 3. Immediately after election, the board of directors shall meet and elect from their number a president, a vice president, and a secretary-treasurer. They shall also appoint a manager who shall look after the hall for the best interests of the company.

SEC. 4. The duties of the president shall be to preside at all meetings of the directors or stockholders. The vice president shall perform the duties of the president in his absence.

SEC. 5. The duties of the secretary-treasurer shall be to keep a record of the proceedings at all directors' or stockholders' meetings and he shall make a report to the stockholders at their annual meeting showing the receipts and disbursements of all funds together with the financial condition of the company at that time and shall pay all bills as allowed by the board of directors.

SEC. 6. The manager shall hold office until his successor is appointed and shall have charge of the renting and upkeep of the hall under the supervision of the board of directors and shall turn over all money received promptly to the secretary-treasurer.

SEC. 7. The board of directors shall meet directly following the stockholders' annual meeting and as often thereafter as the secretary-treasurer may deem necessary.

SEC. 8. The board of directors shall have power to fill any vacancy in the board by appointment, such appointee to hold office until the next annual election.

SEC. 9. The board of directors shall have power to borrow money in the name of and for the company to make improvements or repairs as may be necessary and to provide the necessary funds for the completion of the building and equipment and to pledge any or all of the assets of this company for the payment of such borrowed money.

SEC. 10.—The board of directors shall set aside each year as a sinking fund one-half of the net earnings of the company to retire any stock that may be offered because of the removal of the owner thereof from the county, such stock to be redeemed in the successive order that it is offered and as funds become available. All liabilities shall be paid before the distribution of any earnings is made.

The balance of net earnings shall be paid as dividends each year on the stock basis.

BUILDINGS ERECTED THROUGH VOLUNTARY CONTRIBUTIONS.

Potwin, Kans.—Population of village, 249. Cost of building, \$6,141.

CONSTITUTION AND BY-LAWS.

ARTICLE I.—NAME.

The name of this club shall be the Potwin Community Welfare Club.

ARTICLE II.—CAPITAL AND OBJECT.

SEC. 1.—*Capital*.—This club shall have no capital stock, the funds for the building and maintenance shall be raised by voluntary contributions, and no charge shall be made for the use of the building for purposes hereinafter men-

tioned, provided that the board of trustees shall have power, if they so choose, to charge enough to cover incidental expenses.

SEC. 2.—Object.—It shall be the purpose of this club to build and hold a building that can be used as a place where the real spirit of brotherhood prevails, and to spread that spirit in the community.

To furnish a wholesome, happy center for our community; to promote in every possible way the spirit of business cooperation and mutual helpfulness among the farmers and business men of the community. * * *

ARTICLE III.—MEMBERSHIP.

SEC. 1.—Associate.—Every person living in the vicinity of Potwin is considered an associate member of this club.

SEC. 2.—Active.—Any person over 18 years old may become an active member of this club by enrolling with the secretary and may remain so by reenrolling within thirty days after each annual meeting, and shall have power to vote for members of the board of trustees, and upon all other questions coming before the club; provided, that no new member shall have power to vote within less than thirty days after his enrollment.

ARTICLE IV.—OFFICERS AND ELECTIONS.

* * * * *

SEC. 2.—Trustees.—The board of trustees shall hold office for a term of five years and shall be chosen at the regular annual meeting of the club in the following manner:

At the first annual meeting the club shall choose, in whatever manner they desire, one member for a term of one year, one for two years, one for three years, one for four years, and one for five years, and then at each succeeding annual meeting one member shall be chosen for a term of five years.

SEC. 3.—Other officers.—Immediately after the annual election the board of trustees shall choose from their own membership a president, secretary, and treasurer, who shall serve for a term of one year.

ARTICLE V.—DUTIES OF OFFICERS.

SEC. 1.—Trustees.—The board of trustees shall have general supervision of the club and clubhouse, and all arrangements for the use of the clubhouse shall be made with them.

* * * * *

Kenilworth, Ill.—Erected in a village of 900 population.

ARTICLES OF AGREEMENT OF THE KENILWORTH ASSEMBLY HALL ASSOCIATION.

First. The undersigned, and such other subscribers as may hereafter join them, hereby organize themselves into a voluntary association, to be called Kenilworth Assembly Hall Association.

Second. The object of such association shall be to furnish to the members thereof, and to their families and friends, a suitable meeting place in the village of Kenilworth, to be used for social and educational purposes.

Third. The association shall acquire, either by gift or purchase, the following described property: * * *

Fourth. The title to said property, and such other property as may be acquired, shall be conveyed to five trustees, to be selected as hereinafter stated, in trust to take possession of said property and to manage the same for the benefit of said association. The hall to be erected on said lot shall be con-

structed under their supervision and they shall receive and expend all moneys contributed for that purpose by the members of the association and others and prescribe the compensation to be paid therefor; they may delegate the details of the management, including the receipt of the current income from rents and otherwise, and the payment of current expenditures, to the house committee, but shall annually or oftener receive the net income, and out of the same pay all taxes, insurance, alterations, extensions, and repairs. Should there be a surplus fund not needed for the purposes above mentioned the same shall be subject to the orders and disposition of the association. The trustees shall have the power to sell or encumber said property with the written consent of four-fifths of the members of the association and the unanimous consent of the trustees for the time being.

* * * * *

Sixth. The association shall also elect a house committee of three to hold office for one year and until their successors are elected and may provide by by-law for other officers and their duties. At all elections each member shall have one vote, either in person or by proxy. * * *

New members may be admitted upon such terms as the association may prescribe. Each new member shall subscribe to these articles of association.

Seventh. In case of a sale of the property, as stated in paragraph four, the proceeds of sale shall be used or divided in such manner as may be directed in writing by four-fifths of the then members of the association and by the unanimous consent of the then board of trustees, and in case such direction and consent is not obtained the proceeds shall be divided among the contributors to the funds of the said association or their legal representatives pro rata to their contributions and as they appear in the treasurer's account.

It is the intention of these articles to vest in said trustees the entire legal and equitable estate in said property and to declare that the interest of the members of the association is only in the avails and proceeds of a sale, if any should be made, and is personal property.

These articles may be amended at any annual meeting of the association by an affirmative vote of at least four-fifths of the then members of the association and four-fifths of the then trustees.

STATE LAWS ON COMMUNITY BUILDINGS.

There are laws in nearly all States enabling municipalities and counties to erect, through taxation, town halls and county buildings for government purposes. As the social movement has grown these buildings have also been more extensively used for social purposes. These uses, however, have sometimes been looked upon as of doubtful legality.

Nine States and Ontario, Canada, have recently passed special laws enabling towns and counties to erect community buildings. Some of these laws are especially applicable to townships, thus directly affecting the farming community.

From the viewpoint of the farmers there has been one weakness in such laws. Farmers do not always feel at home in city or town community buildings, because they are not a part of the political unit

which was taxed to build them, nor have they had a chance to vote on the proposition of issuing bonds. While a town or village may be a community social unit, a township seldom is. Farmers live in distinct natural social groups which usually have no fixed governmental boundaries. Townships fix the lines of governmental rather than social groups. Sometimes the social group is a part of two townships, being cut by the township line. Thus unity of action through the local government is impossible.

In order to get around this difficulty, a movement has been started to have laws passed by States, enabling natural social groups to form a unit and erect a community building by taxation. Wisconsin has already passed a law of this kind, and the legislatures of other States are favorably considering the question.

The following laws and digests of laws of different States and of the Province of Ontario, Canada, show the trend of present-day opinion along these lines:

ILLINOIS.

MONUMENTS AND MEMORIALS (1919).

Cities, villages, and incorporated towns having a population of less than one hundred thousand may erect "monuments or memorials in honor of their soldiers and sailors or in honor of any one or more of its notable or distinguished persons." The law allows, "to levy a direct tax of not more than four cents upon each one hundred dollars of all taxable property within the jurisdiction." The memorial building is decided upon by a "petition," which "shall be signed by not less than one hundred legal voters of the city, village, or incorporated town.

COMMUNITY BUILDINGS (1919).

(The complete act is given because it is a typical law for towns.)

AN ACT To authorize towns having a population of fewer than 5,000 inhabitants to establish, erect, and maintain community buildings.

SEC. 1. Be it enacted by the people of the State of Illinois, represented in the general assembly: Subject to the provisions of this act, any town may levy an annual tax of not to exceed two mills on each dollar of the assessed valuation of taxable property therein for the purpose of erecting and maintaining community buildings. Such tax shall be levied and collected in the same manner as general taxes.

SEC. 2. Upon the filing with the town clerk of any town a petition containing the names of not less than fifty legal voters of such town praying that the tax herein authorized be levied, the question of levying such tax shall be submitted to the voters of such town at a special election to be called for that purpose, not less than thirty nor more than sixty days after the filing of such petition: *Provided*, That the question of levying such tax shall be submitted at a regular town election if such election is to be held not less than twenty nor more than ninety days after the filing of the petition; and, *Provided further*, That such question shall not be submitted in any town in which there is a population of over five thousand inhabitants according to the latest Federal census.

SEC. 3. If a majority of those voting on the question of levying a tax for the establishment, erection, and maintenance of a community building shall vote in favor thereof an annual tax of not to exceed two mills on each dollar of the assessed valuation of the taxable property shall be levied and collected for that purpose.

SEC. 4. The establishment or erection of a community building and the maintenance thereof shall be under the supervision of a board of managers. The board of managers shall consist of three persons, residents of the town, who shall be elected at the regular town election for a term of three years. The board of managers shall serve without compensation. The first board of managers shall be elected at a special election called for that purpose after the ratification of the question of levying the tax hereby authorized, one for one year, one for two years, and one for three years, to be determined by lot. Thereafter one person shall be annually elected to the board of managers at the regular town election for a term of three years.

SEC. 5. The board of managers shall have power to lease a building, or buildings, for the establishment of a community building, or to select a site and cause the erection of a building for that purpose, and may exercise any and all other powers necessarily incidental in order to carry out the provisions of this act. The town treasurer shall pay out moneys derived from the tax hereby authorized only on the order of a majority of the board of managers.

SEC. 6. If the board of managers shall deem it necessary to issue bonds for the purpose of obtaining sufficient funds to establish a community building, it shall cause the question of issuing such bonds to be submitted to a vote of the people of the town at an election to be called for that purpose. Notices of such election shall be posted in at least five of the most public places in such town for at least ten days prior to the date fixed for holding such election. Such notices shall state the amount of bonds proposed to be issued, the date of maturity, and the rate of interest to be paid thereon.

The ballots for use in such election shall be in substantially the following form:

For bond issue of dollars, payable in years with interest at the rate of per cent per annum for community building purposes.	
Against bond issue of dollars, payable in years with interest at the rate of per cent per annum for community building purposes.	

Such bonds shall mature on or before twenty years from the date thereof and shall bear interest at a rate not to exceed five per cent per annum, payable annually or semiannually, as the board of managers may determine. If the interest is to be paid semiannually, that fact shall be stated in the notices of election and on the ballots. Such bonds shall be sold at not less than par. From the proceeds of the annual tax levy authorized by this act the board of managers shall provide a sinking fund for the retirement of such bonds, and such bonds shall be payable only out of such proceeds.

SEC. 7. The community building of any town may be dedicated to the soldiers and sailors of such town and bronze tablets or other memorials in honor of such soldiers and sailors may be placed therein by the board of managers.

SEC. 8. Subject to the reasonable rules and regulations of the board of managers, the community building shall be for the free use and benefit of the inhabitants of such town for lectures, concerts, free amusements and entertain-

ments, and all other general educational purposes. The annual town meetings and other public assemblies may be held therein. The board of managers shall have power to lease, temporarily, the community building, when not in use for public purposes, for any reasonable and legitimate private use on such terms as may be deemed reasonable and proper. Private lessees of a community building may charge admission fees. All money received from temporary rentals shall be turned over to the town treasurer and shall be used only for the maintenance of the community building.

SEC. 9. The board of managers shall make a full and complete annual report of all its actions to the town board of auditors.

PUBLIC COMFORT STATIONS (1919).

Cities of less than 100,000 population, incorporated towns and townships and villages may provide "an institution with waiting rooms, rest rooms, toilet rooms, for men and women, lavatories, check rooms, drinking water, etc.," also attendants' quarters. Money provided by "tax not to exceed one and one-third mills on the dollar." Proposition must be approved by majority vote at a regular election. Question submitted to voters on petition of 100 legal voters filed 60 days prior to the election.

IOWA.

MONUMENTS AND MEMORIALS.

(The complete law is given because it is typical of the laws on soldiers memorial buildings.)

Be it enacted by the General Assembly of the State of Iowa

SEC. 1. Counties, cities, and towns, including cities under commission plan and those under special charter, shall have power to purchase or condemn ground for, erect and equip or purchase and equip, a building as a soldiers', sailors', and marines' memorial commemorative of their military and naval service, and which shall be given an appropriate name, and shall have special accommodations or provisions for soldiers, sailors, nurses, and other persons who are or have been in military or naval service of the United States. Such building may be or include military headquarters, memorial rooms, library, assembly hall, gymnasium, natatorium, club rooms, and rest rooms; it may include city hall and offices for any county or municipal purpose, or community house, or recreation center; or it may be a memorial hospital, or it may be for any one or more such purposes; and for similar or appropriate purposes may be extended to general community and neighborhood uses; all under the control and regulation as to charges and otherwise, of the city or town council, with the advice and cooperation of the community civic congress. Such building may be erected as an appropriate annex to any other city or public building, or by reconstructing the same.

SEC. 2. In the case of municipalities the city or town council shall appoint a community civic congress, as mentioned in section four (4), chapter one hundred eighty-two (182), laws of the thirty-seventh general assembly, being three persons, residents of said city or town, especially fitted for and interested in all matters pertaining to community improvements, not only as heretofore provided by law but also with reference to improvements contemplated by this act; they shall serve without compensation.

SEC. 3. For the purpose of providing funds for the acquisition of necessary grounds therefor, and purchasing, erecting, constructing, or reconstructing such building, and for the necessary equipment therefor, the county, city, or town may issue bonds, to be known as liberty memorial bonds, to be issued and sold as provided by law; they shall provide for portions of such bonds to become due at different, definite periods, but none in less than five (5) nor more than fifty (50) years from date. In issuing such bonds such county, city, or town may become indebted in an amount which, added to all other indebtedness, shall not exceed five (5) per centum of the actual value of the taxable property in such county, city, or town as determined by the last State and county tax lists, anything in section thirteen hundred six-b (1306-b), supplement to the code, 1913, and acts amendatory thereto, to the contrary notwithstanding. For the purpose of liquidating such bonds, together with the interest thereon, such county, cities, and towns shall levy upon all the property within the limits thereof, subject to taxation for such purpose, in addition to all other taxes provided by law, a special tax not exceeding in any one year five mills on the dollar for a period of not exceeding fifty years.

SEC. 4. Upon petition of fifteen per cent of the legal voters of any county, city, or town, the question as herein provided shall be submitted to the voters of said county, city, or town. Such petition shall ask that an election be called, shall refer to this act, shall suggest generally the nature and uses of the proposed liberty memorial building. No such building shall be erected and equipped, or purchased and equipped, under the provisions of this act unless a majority of the legal voters voting thereon vote in favor of the same at a general, municipal, or special election called for that purpose. Notice of such election shall be given in two newspapers published in said county, city, or town, if there are two; but if not, then in one, once each week for at least four consecutive weeks. But if no newspaper is published within the limits of the corporation, then such notice may be given by posting in three public places within the limits of said corporation, two of which places shall be the post office and the mayor's office of such city or town, and by publication for four consecutive weeks in a newspaper of general circulation in the county. The election shall be held not less than five nor more than twenty days after the last publication of such notice. The questions to be submitted shall be in the following form: "Shall the county, city (or town) of ——— erect and equip (or purchase and equip) a liberty memorial building as provided in chapter ——— (naming this act) of the laws of the thirty-eighth general assembly, and issue bonds therefor in the amount of ——— dollars?"

SEC. 5. In case a building be constructed or purchased under this act, the county, city, or town shall thereafter provide annually a levy of not more than three mills on all the taxable property within said county, city, or town for the development, operation, and maintenance of such building in care of a city or town, and it shall seek advice and suggestions of the community civic congress.

SEC. 6. Gifts and bequests to the county, city, or town for any of the purposes provided in this act are hereby authorized; the same shall be used and applied as provided in this act and as especially stipulated by the donor.

KANSAS.

"Counties and cities may appropriate a sum not in excess of \$3,000 for the erection of memorials to soldiers." Action is initiated by a petition of 25 per cent of the voters of the district to the proper officials to submit the question to a vote of the people of the district. The petition states the character of

the memorial and the approximate cost. If such memorial be a building, management and control is vested in a board of three resident trustees appointed by the usual officials, who shall serve without compensation. Maintenance expenses may be met from the general fund of the county or city or from a special fund erected by a levy of not more than one-tenth of one mill per annum.

MASSACHUSETTS.

"Cities and towns are authorized to accept gifts or bequests and to appropriate money for the erection and equipment of buildings or other suitable memorials to soldiers, sailors, and marines." "May borrow within the debt limit, may issue bonds or notes payable in not more than twenty years, in accordance with section 14," etc. "May provide for a board of trustees, which shall have charge and control of the construction and custody and care." "In towns the board shall consist of the chairman of the board of selectmen, ex officio, and three members selected by the town in the same manner as other town officers."

MICHIGAN.

"Cities are empowered to acquire land for the purpose of erecting thereon a suitable memorial to soldiers and sailors," which "may be of such nature as to be used as a museum, art gallery, library, auditorium room, or for any other public purpose." "That taxes collected and indebtedness created shall not cause the limit of taxes and indebtedness established by law to be exceeded." "The custody, management, and control may be vested in such a board now existing or which may be created as the legislative body of the city shall designate."

NEBRASKA.

"Counties, cities, villages, and townships may erect or aid in the erection of statues, monuments, or other memorials to soldiers." No action can be taken until 20 days after passage of authorizing resolution, and meanwhile, on petition of 15 per cent of voters, resolution must be submitted to electors for approval, at the next general or special election, which must be 30 days after filing of petition.

When presented with a petition signed by 10 per cent of voters asking for the erection of a memorial the usual officials of the county, town, etc., "shall proceed therewith, without delay, subject to this referendum petition, or shall provide for the submission of such a proposition to a vote of the people at a general or special election occurring 30 days after the filing of the petition, and if approved by a majority shall proceed therewith."

NEW JERSEY.

"Every municipality shall have power to provide for the construction, with the aid of popular subscription or otherwise, hospitals, schools, or other public buildings" as memorials to soldiers. "The municipality shall appropriate such sum of money as may be necessary to accomplish the purpose, over and above the amount raised by popular subscription." The municipality shall name five citizens, including the mayor, as a commission, without pay, to supervise the acquisition of the site and erection of the building.

TENNESSEE.

"County courts are authorized to appropriate money to be expended in the erection of permanent monuments or buildings or libraries for those who served in the World War." "No sum in excess of \$25,000 shall be appropriated

in any one county. The county court shall elect five citizens of the county to be known as the county building commissioners, to superintend the erection of said monument or building."

WISCONSIN.

The Wisconsin law is given in full because it is typical of the attempt to constitute a new territorial district, based on a contiguous social group rather than one limited by political boundaries.

WISCONSIN COMMUNITY CENTER ACT.

AN ACT to create sections 937f to 937t, inclusive, of the statutes, relating to community centers and subdivision (47) of section 1038 of the statutes, relating to exemption of property of such community centers from taxation.

The people of the State of Wisconsin, represented in senate and assembly, do enact as follows:

SEC. 1. Fifteen new sections are added to the statutes and a new subdivision is added to section 1038 to read:

"SEC. 937f. 1. A community center may be created and a community house therein erected, maintained, operated, and managed in any tract of contiguous territory containing either an area of not less than sixteen square miles or a population of at least five hundred inhabitants, such territory to be bounded by town, school district, section, quarter section, or ward lines, or streams, lakes, swamps, or similar natural boundaries. Such house, if dedicated to the memory of the soldiers and sailors of the United States may be called by the name of memorial community house of such district.

"2. A petition praying for submission of the question establishing such a community center to the electors of such tract qualified to vote for State officers may be presented if wholly within any town, city, or village, to the chairman, mayor, or president thereof, as the case may be, and if comprising territory in two or more such public corporations to the said officer of the corporation having the greatest area in such proposed district. Said petition shall designate a proposed name and shall describe the boundaries of the proposed community center, which shall not include any territory included in any community center already organized hereunder, and shall be signed by at least one-fourth of the persons resident therein qualified to vote at any school district meeting.

"3. Said officer shall within ten days of the receipt of said petition notify the said officers of any other public corporations a part of whose territory is included of the receipt of said petition, and shall set a date and place for a meeting of all such officers for the purpose of fixing a time and place for holding such community center election, at which time and place it shall be their duty to meet and fix the time and place for holding the election hereinafter provided for, which shall not be more than sixty days after presentation of the petition. If any officer is unable to attend such meeting he shall delegate one of the other officers of his town, village, or city, as the case may be, to attend and act in his place. In case said tract lies within a single public corporation, the officer to whom the petition is presented shall within five days of its receipt fix a time and place for holding such election. The election shall be noticed and conducted for the entire tract of territory which is to be included in the proposed community center by the election officers of the corporation in which the election is to be held.

"4. The time and place of such election being fixed, the person to whom the petition was presented shall forthwith notify the clerk of his corporation of

the time and place fixed for such election, and such clerk shall at once cause ten days' notice of such election to be given by posting a copy thereof in at least six different public places in such tract or territory, or by publishing such notice in any newspaper published therein once each week for two weeks immediately prior to the time set for holding the election. The election shall be conducted and the vote canvassed according to the statutes for conducting town meetings.

"Sec. 937g. 1. In all cases the vote shall be by ballot, with separate ballot boxes for each public corporation of which any territory is included in the petition. Ballots written or printed shall be either "for the community house," or "against the community house," or either "Yes" or "No" or any other designation plainly showing the voter's intent. If a majority of the electors voting from each public corporation of the territory proposed to be included are in favor of such organization, the proposal shall be deemed carried; otherwise not. If carried, the result shall then be certified at once by the election officers within six days thereafter to the clerk of each town, village, and city concerned, and to the clerk of the county, and by the latter promptly to the secretary of state, each of whom shall file such certificate, and such tract or territory shall thereupon constitute a public corporation from the date of such election of the name designated in the petition.

"2. The expenses, if any, of any such election conducted for the purpose of determining a community center shall be borne in the first instance by the municipality to whose officer the petition is presented, which shall have a claim therefor against the community center corporation if organized, and if defeated, against each other corporation for its share apportioned on the basis of the assessed valuation of the territory included in the petition as last determined by the local boards of equalization.

"Sec. 937h. 1. The officers of such a community center shall be a director, treasurer, and clerk, with the usual powers and duties of such officers, who shall constitute the community board, and shall conduct and manage its affairs and have power, subject to change by any succeeding center meeting, to alter or change the name of the community center.

"2. The term of each shall be three years, beginning with the annual community center meeting held on the second Monday in March, and each officer elected shall continue in office until his successor shall have been chosen; provided that at the first election the clerk shall be chosen for one year, the treasurer for two years, and the director for three years. Temporary officers may be chosen at the same election at which the question of establishing a community center is submitted to hold until the regular annual election thereafter. In such case a separate ballot box shall be provided for the election of officers, and a plurality of the votes cast shall be sufficient to elect.

"Sec. 937i. 1. The annual community center meeting for the election of officers and the transaction of other business shall be held on the second Monday in March, unless that be a legal holiday, in which case it shall be held the next day, and in the community house, or in some other building determined upon by the board and specified in the notice.

"2. The election of officers shall be by ballot conducted publicly by the officers. The polls shall be opened at one o'clock in the afternoon of the day fixed by law, and shall be closed at eight o'clock of the same day. Immediately after the polls are closed the ballots shall be publicly counted and the result announced and recorded by the clerk. The annual community center meeting provided by section 937n shall then be held.

"Sec. 937j. It shall be the duty of the board to meet on the Saturday immediately preceding the annual meeting, carefully examine the accounts of the

treasurer, and make up a full and itemized report of all receipts and expenditures since the last annual meeting of the amount in the hands of the treasurer or the amount of the deficit, if any, for which the centre is liable, of the amount necessary to be raised by taxes for the maintenance of the community house for the ensuing year, and of the amount required to pay the interest or principal of any debt due or to become due during the year, which report shall be submitted in writing at the annual meeting and recorded by the clerk at length with the action thereon in the proceedings of the meeting.

"SEC. 937k. The clerk shall give at least six days' previous notice of the annual meeting by posting notices therefor in six or more public places in the district, one of which shall be affixed to the outer door of the community house, and he shall give like notice for any adjourned meeting if the adjournment be for more than one month.

"SEC. 937l. Special meetings shall be called by the clerk, or in his absence by the director or treasurer on the written request of one-fifth of the legal voters of the district, and notices thereof specifying particularly the business to be transacted shall be posted in the manner prescribed for calling the annual meeting; and the electors when lawfully assembled at a special meeting shall have power to transact the same sort of business as at the first or annual meeting except the election of officers. No tax or loan or debt shall be voted at a special meeting unless three-fourths of the legal voters shall have been notified either personally or by a written or printed notice left at their places of residence stating the time, place, and objects of the meeting and specifying the amount proposed to be voted at least six days before the time appointed therefor, exclusive of the day on which the meeting is to be held and then voted by a two-thirds vote of the members present.

"SEC. 937m. Every resident person qualified to vote at a school district meeting shall be entitled to vote at any annual or special meeting.

"SEC. 937n. The persons qualified to vote at the community-center meeting when assembled at the first and each annual meeting or at any adjournment thereof shall have power:

"(1) To appoint a chairman and clerk pro tem to act in the absence of either;

"(2) To adjourn from time to time as occasion may require;

"(3) To vote such tax, not to exceed nine mills on each dollar of the assessed valuation of all the taxable property within the district for the year in which such tax is levied, as the meeting shall deem sufficient to purchase or lease a suitable site for, to build, hire, or purchase, a community house, and to keep in repair and furnish the same with necessary furniture and ventilating and heating apparatus, and to provide for its equipment and maintenance, and for such meetings and proceedings therein as to them seem for the best interests of the community;

"(4) To impose such tax as may be necessary to discharge any debts or liabilities of the district lawfully incurred;

"(5) To authorize the community-center board to borrow money for any of its lawful purposes.

"SEC. 937o. The board may fill by appointment any vacancy that may occur in their number within ten days after such vacancy shall occur; and if such vacancy shall not be so filled the town, village, or city clerk of the town, village, or city in which the community house is situated shall fill such vacancy by appointment. Any person upon being notified of his appointment shall be deemed to have accepted the same, unless within five days thereafter he shall file with the clerk or director a written refusal to serve, and any person so appointed shall hold office until the next annual meeting, at which the electors shall fill such vacancy for the unexpired term.

"SEC. 937p. If any community center at its annual or any subsequent special meeting prior to the third Monday of November following shall not vote a tax sufficient to maintain a community house for the current year, the board, on or before the next Wednesday following said third Monday in November, shall determine the sum necessary to be raised to maintain such community house, and the clerk shall forthwith levy and certify to the town, village, or city clerk, as the case may be, the amount so determined.

"SEC. 937q. The incorporation of a part of the territory of a community-house district organized under the provisions of sections 937f to 937s, inclusive, as a village or city shall not affect the organization of such community centre.

"SEC. 937r. All taxes provided for in sections 937f to 937s, inclusive, shall be certified, levied, collected, and paid over as in the case of single or joint common school districts of the State.

"SEC. 937s. Such community house shall be used for the following purposes: Public gatherings for information, discussion, recreation, amusement; public banquets, suppers, and festivals; athletic games; rest rooms; rooms for community agricultural projects; and such other purposes as the electors may deem fit; and the board shall adopt rules and regulations governing its maintenance, operation, and management.

"SEC. 937t. 1. Any community center organized hereunder may be dissolved by vote of the majority of the qualified voters of such center at any annual meeting held at an election for such purpose, held more than four years after the date when such community center was organized, provided notice of such election to dissolve was included in the notice of such election after petition therefor, signed by at least two-fifths of the community center electors, which election shall be by ballot cast during the hours when the polls are open.

"2. After such vote of dissolution, the property of such dissolved district shall be disposed of by grant or otherwise, and the proceeds applied to the discharge of its debts, and the remainder, if any, paid over to the treasurers of the different municipalities of which such district was composed, in proportion to the valuation of the property of such municipalities going to make up such district, as appears from the last tax rolls of such municipalities and the dissolution certified in the manner and to all public officials having record of the organization.

"(SEC. 1038) (47) All real and personal property of any community-house district, organized under the provisions of sections 937f to 937s, inclusive."

SEC. 2. This act shall take effect upon passage and publication.

ONTARIO, CANADA.

The Ontario community center act provides as follows:

The minister of agriculture may grant aid to the municipal corporation of a township for the purpose of assisting in providing a community hall and the laying out of an athletic field. The corporation of the township may issue debentures in the manner provided by the municipal act. Such grant shall not exceed 25 per cent of the cost of the building or \$2,000 in any one case, but grants may be made for more than one hall in one township. The council of a township may provide for the establishment of a community hall and athletic field in the township or in any incorporated village adjacent or contiguous thereto, and may enter into an agreement with the council of any adjoining township or village for the joint use of the community hall and athletic field by the inhabitants of the municipalities upon such terms as to contribution to the cost of the hall and athletic field and as to the maintenance thereof as may

be agreed upon. But, notwithstanding any such agreement, the aid to be granted under the act shall not exceed the amount mentioned in section 3.

Every community hall and athletic field shall be under the management and control of a board appointed by the council of the township composed as follows:

(a) Two members of the township council, and (b) five members selected by the council from amongst the officers of the local organizations in the township, not being religious or fraternal organizations, for the use of which hall is established, and in selecting such representatives the council shall have regard to the contribution by each organization to the erection and maintenance of the community hall.

The site of the community hall shall be determined by the board, but every hall shall provide the following accommodations: Assembly room with movable seats, stage, and other equipment; reading room, including library, kitchenette.

Every hall erected under this act shall be available for any public gathering of educational, fraternal, religious, or social nature or for the discussion of any public question, and no organization shall be denied use of the building for religious, fraternal, or political reasons.

MISCELLANEOUS STATE LAWS.

Kansas.—Township halls: A petition is directed to township board signed by at least one-third of the electors, stating what is desired, including amount of the proposed bond issue, which shall not exceed \$5,000, and requesting an election. If the board finds the request legal it calls an election. If the majority at the election is affirmative the bonds are carried and the board is authorized to select a building site and issue bonds and permit.

Missouri.—Counties with State aid are empowered to erect soldier memorial buildings, etc.

Supreme Court held that townships have implied power to erect buildings for township meetings and for township offices.

New Mexico.—New Mexico has a law incorporating the Memorial Hall Association of New Mexico for the purpose of constructing a Memorial Hall in commemoration of the services of soldiers, etc., and to receive private contributions for this purpose.

North Dakota.—North Dakota has authorized counties to erect memorials for soldiers, etc., and to levy taxes for the same.

Pennsylvania.—An act has been passed authorizing joint county and municipal buildings. As a result of this recent law soldier memorial buildings with community social features are being erected.

South Dakota.—Attorney general held opinion similar to that of Supreme Court of Missouri.

Vermont.—Vermont and other New England States build town halls for governmental purposes, and incidentally for limited social uses.

Washington.—School districts are empowered to erect community assembly halls on school property.

Wisconsin.—Court ruling similar to that of Missouri Supreme Court.

Special act passed enabling towns to operate a public hall or theater.

HOW TO GO ABOUT ORGANIZING A COMMUNITY BUILDING.

When a community begins to feel that it is in need of a building for its social and civic activities and begins to consider the question, it proceeds with much care. A careful study is made of local conditions. The value and advantages of such a building are made known. Its usefulness and need are made apparent. The organizations which

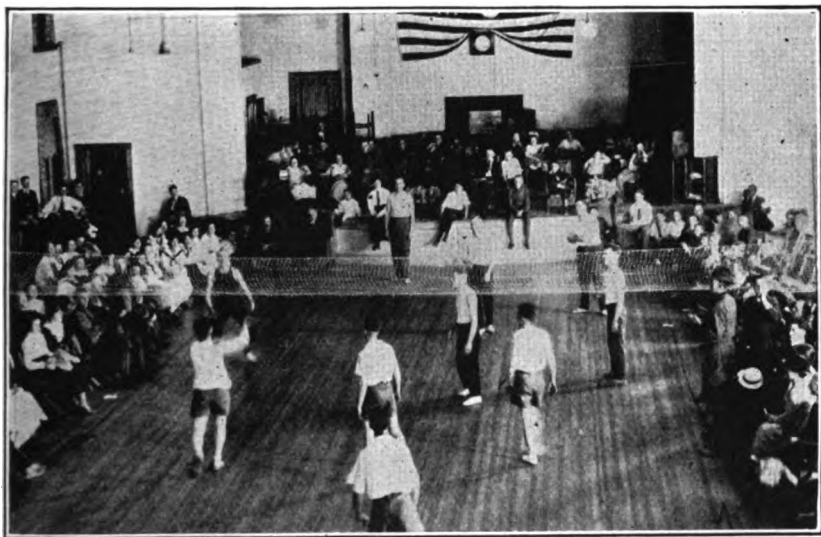


FIG. 9.—Auditorium of community building at Manhattan, Kans., showing its use for athletic events.

may be expected to use the building are listed. The activities which will naturally be carried on in the building are enumerated. The kind of building needed is decided upon. Possible floor plans are studied. The amount of money needed and the manner of raising it are carefully thought out. The kind of organization best suited to the needs of the particular community and building is determined upon.

Several weeks, or even months, are often consumed in this process. It may be likened to the time of planting. The seed—the community-house idea—has been sown and properly cultivated.

This cultivation is a community process. The idea is talked over and discussed by everybody. Where the best results are secured no one appears to be in charge of or pushing the movement. No group

or clique or organization is in the forefront directing matters. If a directing force is needed, it comes, as little noticed as possible, from the background or from below. The movement must be voluntary and spontaneous.

The public benefit and the common good are emphasized, and not the advantage to be gained by any particular society. The idea grows and takes shape in the minds of the people through discussion. No set plan is sent down from above, as it were, for adoption. After the people have talked over the proposition from all sides and the benefits to be derived are known to the whole community and it is commonly agreed that such a building should be erected, then the movement is aided by proper open direction and guidance. While the idea is simmering in the minds of the people it is often found



FIG. 10.—Interior of community building at Oceanic, N. J., showing use for sewing activities of women's organizations.

advisable to have important local civic and social organizations each appoint a representative on a committee more fully to study the matter. Such organizations may be the farmers' club, women's club, churches, the improvement society, the school, and the local health organization. In large towns the farm bureau, the athletic association, and the chamber of commerce are added. This committee takes people into its confidence and shares its ideas and opinions with them and tries to get their ideas also. Bulletins and literature on community buildings are secured from the State and National Departments of Agriculture and studied.

When plans begin to reach a formative state a public mass meeting is generally called at which all the people are urged to be present.

Here preliminary ideas and plans arrived at are submitted, talked over, and approved. New committees on details are appointed. These are often committees to study preliminary ideas of building finance and organization, and a committee to visit and study some other community house of the kind desired, if such a building is within reach. If it does not seem advisable to send such a committee, it is often thought well to invite a person prominently connected with the erection of some similar building to come and talk to the people, so that they may have the benefit of the experience of another community in undertaking a similar enterprise. At a final mass meeting the concluding decisions are presented and the committees are ordered to go ahead with the work. By proceeding in this way the cordial interest of practically the whole community is aroused.

PROBLEMS OF PLANNING AND ORGANIZATION.

Special points to be considered are size of building, floor plans, cost, how building is to be financed, money available, uses to which it will be put, and organization.

In organization care should be taken to determine (1) title to the building, where it will rest; (2) membership, its extent; and (3) control, i. e., the powers, duties, and method of the election of the board which will exercise the delegated authority of the members. This board of directors or trustees gives advice and counsel, develops methods of procedure, originates plans, and carries out the wishes of the members. It is the responsible body representing the association and controlling at first hand the building and its activities.

The manager is generally appointed by the board or elected by the association to have direct charge of the activities of the building. In small communities this official may be the caretaker; in larger ones a secretary or physical director. His position is often one of great usefulness.

Various committees are often appointed or elected to have charge of different kinds of work connected with the activities carried on in the building. Among such bodies may be mentioned the social committee, business committee, house committee, grounds committee, and entertainment committee.

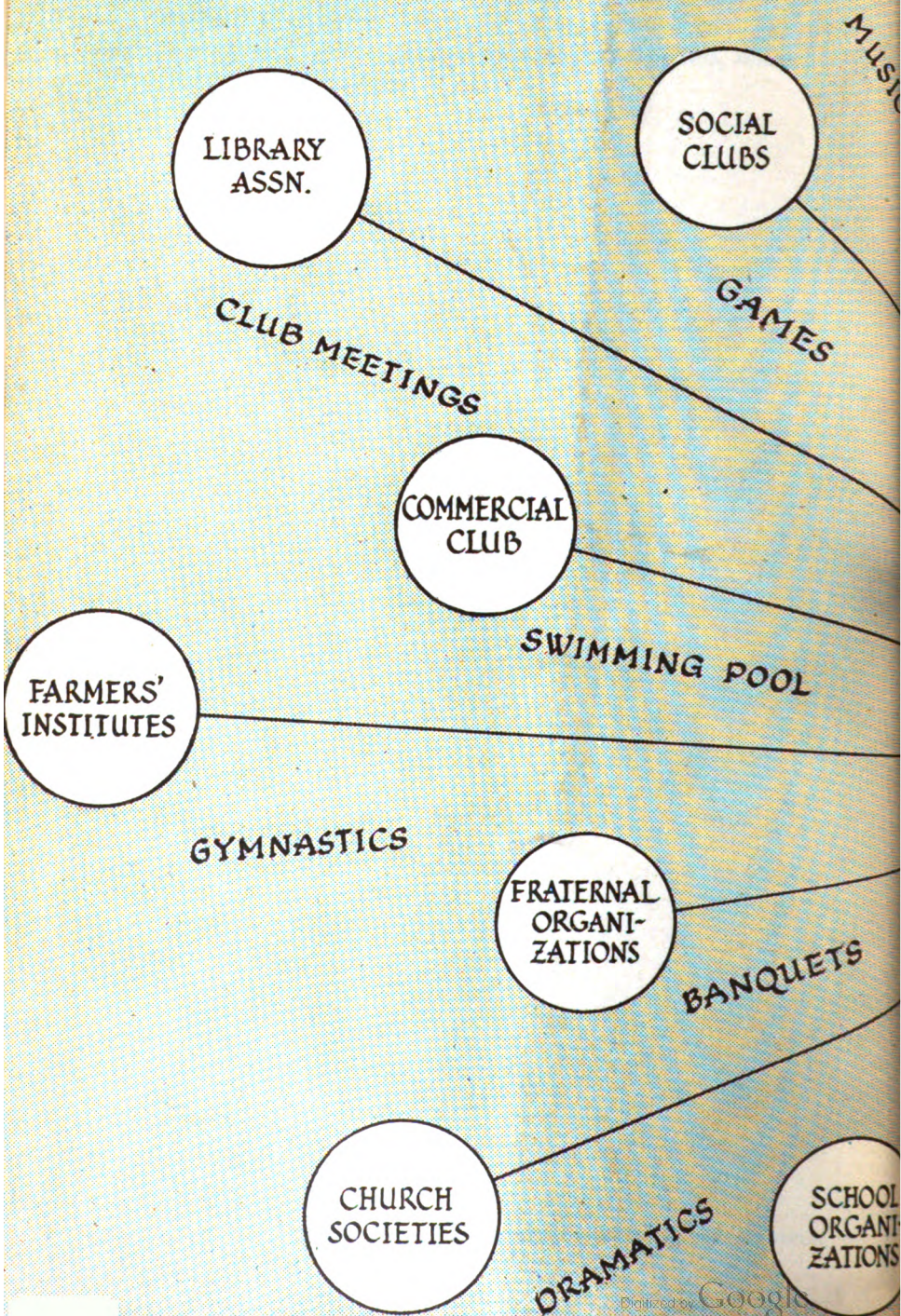
The constitution, the organic body of rules and regulations outlining the aims, powers, and limitations of the organization, the rights and duties of members, etc., has already been discussed.

ERECTION OF THE BUILDING.

This is usually a local and community affair. Everybody helps by giving money, labor, or materials. Local people do the work as

far as possible. Voluntary aid is apparent in every way. Materials are from the locality as far as possible. During the process of building various social events, such as raising bees, are held. The women assist by serving lunches and dinners during the work.

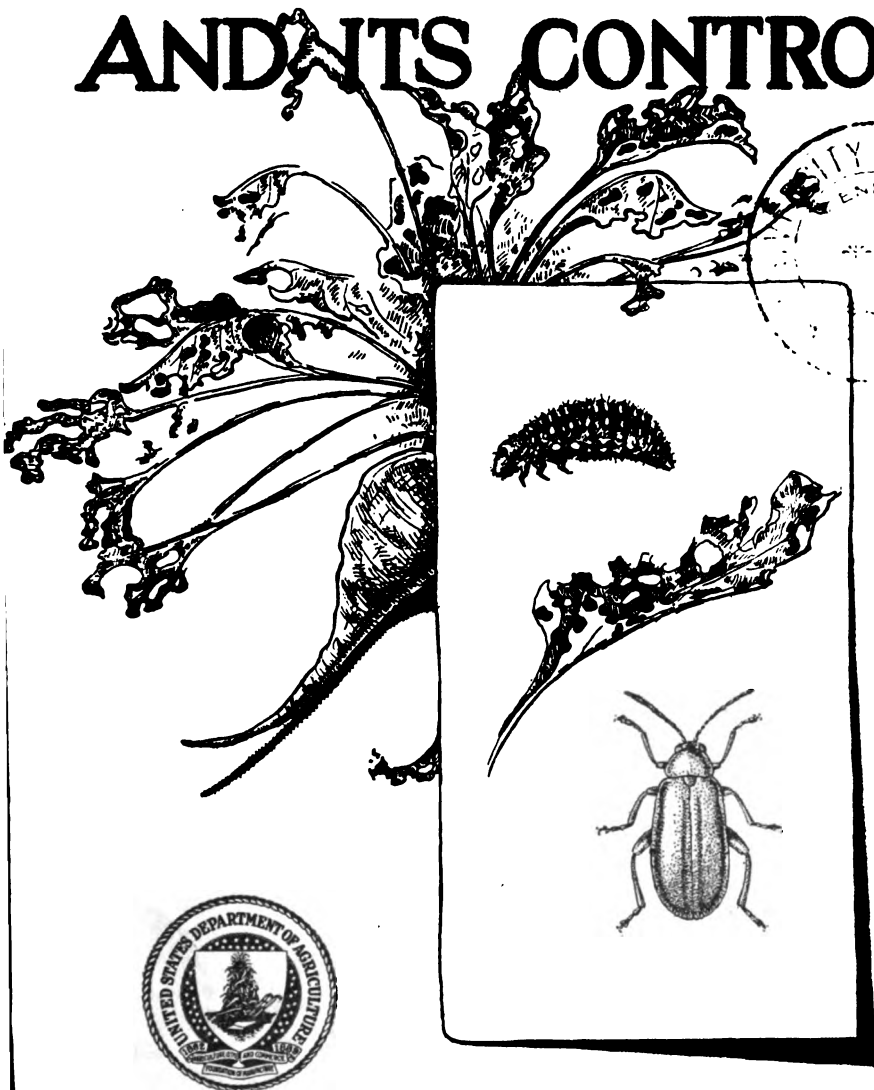
The completion of the building is often followed by a gala dedication, with speaking on community subjects, athletics, music, a banquet, and similar exercises.



41.9: 1193

FARMERS' BULLETIN — 1193
UNITED STATES DEPARTMENT OF AGRICULTURE

**THE
BEET LEAF-BEETLE
AND ITS CONTROL**



THE SUGAR-BEET industry of the Rocky Mountain States is menaced by the presence of the beet leaf-beetle. Both the larva and beetle stages injure the foliage, especially of young sugar beets, and also attack table beets of all kinds and spinach.

The beetles may be trapped by placing heaps of weeds or bundles of hay or straw where the beetles will seek them for winter quarters. Here they may be destroyed by burning between the middle of November and March.

Contribution from the Bureau of Entomology

L. O. HOWARD, Chief

Washington, D. C.

March, 1921

THE BEET LEAF-BEETLE¹ AND ITS CONTROL.

F. H. CHITTENDEN,

Entomologist in Charge, Truck-Crop Insect Investigations.

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AN IMPORTANT ENEMY TO SUGAR BEETS IN THE ROCKY MOUNTAIN STATES.

IN THE Rocky Mountain States the sugar beet is subject to injury by a yellowish beetle known as the beet leaf-beetle or "alkali bug." The main injury is due to attack by the larvæ or young, but the beetles also inflict considerable damage, hundreds frequently being found on a single plant, which is either entirely consumed or so injured that it shrivels and dies. Prior to 1897, when injury was noted both in New Mexico and in Colorado, injury by this insect was unknown, it having confined itself to such plants as sea-blite, Russian thistle, and saltbush.

DESCRIPTION.

The adult beet leaf-beetle measures from one-fourth to one-third of an inch in length, is of oblong form narrowed in front, and in color is pale yellow or buff, sometimes becoming smoky or nearly black, with the wing-covers yellowish or darker and more or less distinctly striped with black. (See fig. 1, a.)

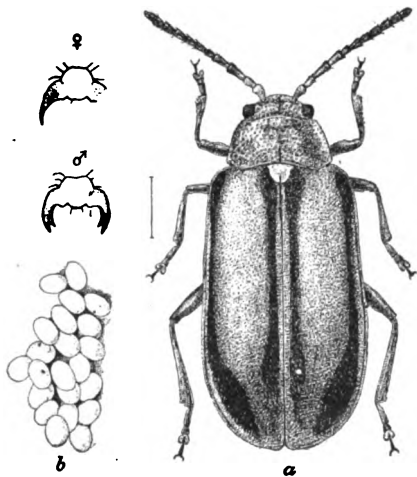


FIG. 1.—The beet leaf-beetle: a, Beetle; b, egg mass; ♀, claw of leg of female; ♂, ditto of male, a, Much enlarged; b, more enlarged; ♀, ♂, highly magnified.

¹ *Monoxia puncticollis* Say.; family Chrysomelidae, order Coleoptera.

The egg (fig. 1, b) is rounded, oval, pale orange-yellow when first laid, changing to dull brownish gray, convex above, flattened on the lower side where attached to a leaf, and the surface is minutely pitted.

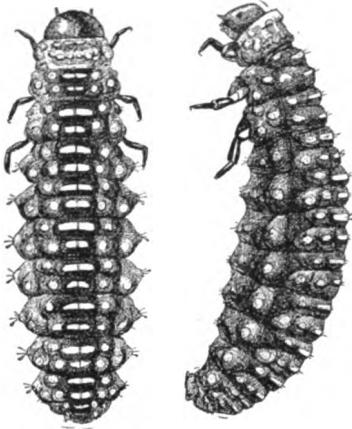


FIG. 2.—Beet leaf-beetle: Dorsal view of larva at left; profile view at right. Much enlarged.

Eggs are deposited usually on end in irregular clusters, sometimes in layers, varying in number from 2 to 50 on either the upper or lower surface of leaves of beets and other food plants. The larva, when mature, is dark olive brown, spotted with pale yellow tubercles arranged in rows. (See fig. 2.) The head is shiny black; as are portions of the legs, which are rather long and slender. The length is about three-sixteenths of an inch.

The pupa (fig. 3) is nearly twice as long as wide, pale yellow, the head prominent, bent downward with the legs folded, as shown in the illustration. The length is from one-fourth to five-sixteenths of an inch.

DISTRIBUTION.

The beet leaf-beetle occurs along the Atlantic Seaboard from Massachusetts to Florida, in California near the seacoast,² and in the alkaline regions of Colorado, Utah, New Mexico, Arizona, Idaho, and Montana. In its eastern occurrence it is maritime and not injurious. It also occurs in portions of Kansas and Texas. See map (fig. 4).

FOOD PLANTS.

The adults feed on sugar beets (figs. 5, A, B, and 6), garden or table beets, mangelwurz, Swiss chard, and spinach; on lamb's-quarters (fig. 5, C), sea-blite (fig. 5, D), Russian thistle, saltwort, saltbush, sea-purslane, and pigweed.³

The larvæ are more restricted in their diet, feeding on sea-blite, lamb's-quarters, Russian thistle, and sugar beet only, so far as observed. Eggs are often deposited on other plants, but the larvæ have not been observed to develop on them.



FIG. 3.—Beet leaf-beetle: Pupa much enlarged.

² The innoxious maritime forms occurring along the Atlantic and Pacific coasts may be distinct geographical races.

³ *Amaranthus retroflexus*.

The beet leaf-beetle, under normal conditions, subsists upon the weeds mentioned, which grow in waste alkali soil, and as long as there is a supply of these plants sugar beets are little damaged. In the spring, before the weeds are abundant, overwintered beetles often infest small young beets, completely destroying them. Later the insects develop in such numbers on the weeds that the latter are killed. The insects then resort to sugar beets for food. Many hundreds of acres of beets are thus infested every year. (Fig. 6.) The beet leaf-beetle is injurious also because it acts as a carrier or distributor of the spores of the leaf-spot disease of beets.⁴

The beetles cut large, irregular holes through the leaves of the sugar beet and the larvæ do similar injury, eating pits in the leaves, frequently without cutting through.

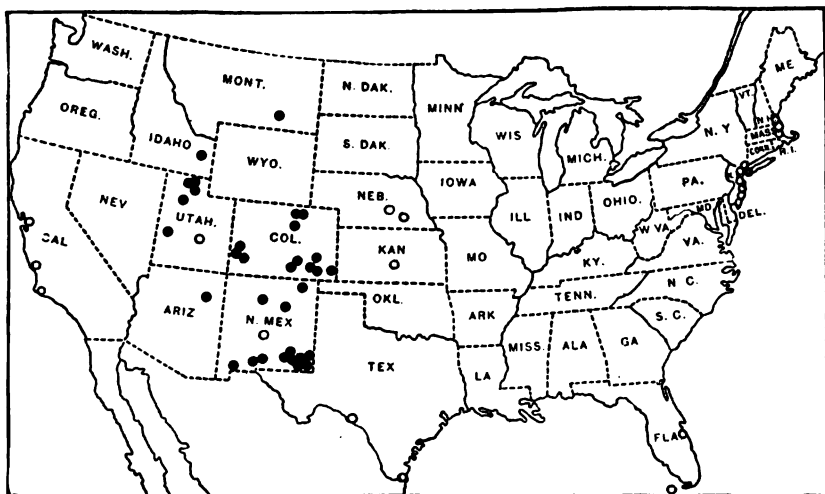


FIG. 4.—Map showing distribution of beet leaf-beetle. Large dots show injurious distribution; circles, innoxious localities.

When mature the larvæ leave the plants, burrow into the soil to a distance of half an inch or two inches, and form cells in which they transform to pupæ and then to adults.

LIFE HISTORY.

In the Arkansas Valley in Colorado and in regions having a similar temperature two generations or broods and a partial third brood are produced each year. The beetles pass the winter on the surface of the ground in alkali areas under tufts of grass, heaps of dead weeds, and other rubbish, a favorite location for this purpose being under tufts of "tickle grass,"⁵ a habit which may be utilized to advantage in controlling the pest.

⁴ *Ceroospora beticola*.

⁵ *Panicum capillare*.

The beetles issue from their winter quarters in March and April, feed, mate, and deposit their eggs. The first generation of beetles from these eggs, as observed in Colorado, appears late in May or

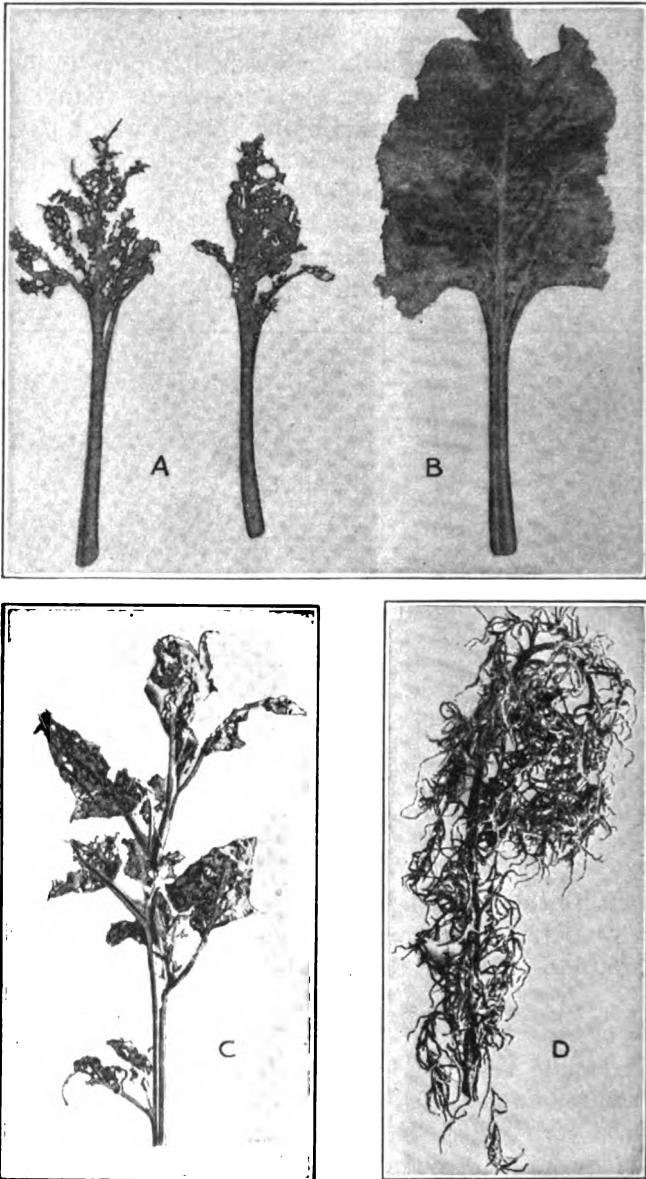


FIG. 5.—Food plants of beet leaf-beetle: A, Sugar-beet leaves riddled by beet leaf-beetle; B, a less injured leaf; C, lamb's-quarters killed by larvæ of beet leaf-beetle; D, sea-blite killed by same.

early in June, and the second generation becomes mature during the latter part of July. The eggs hatch in from 8 to 18 days, the larvæ

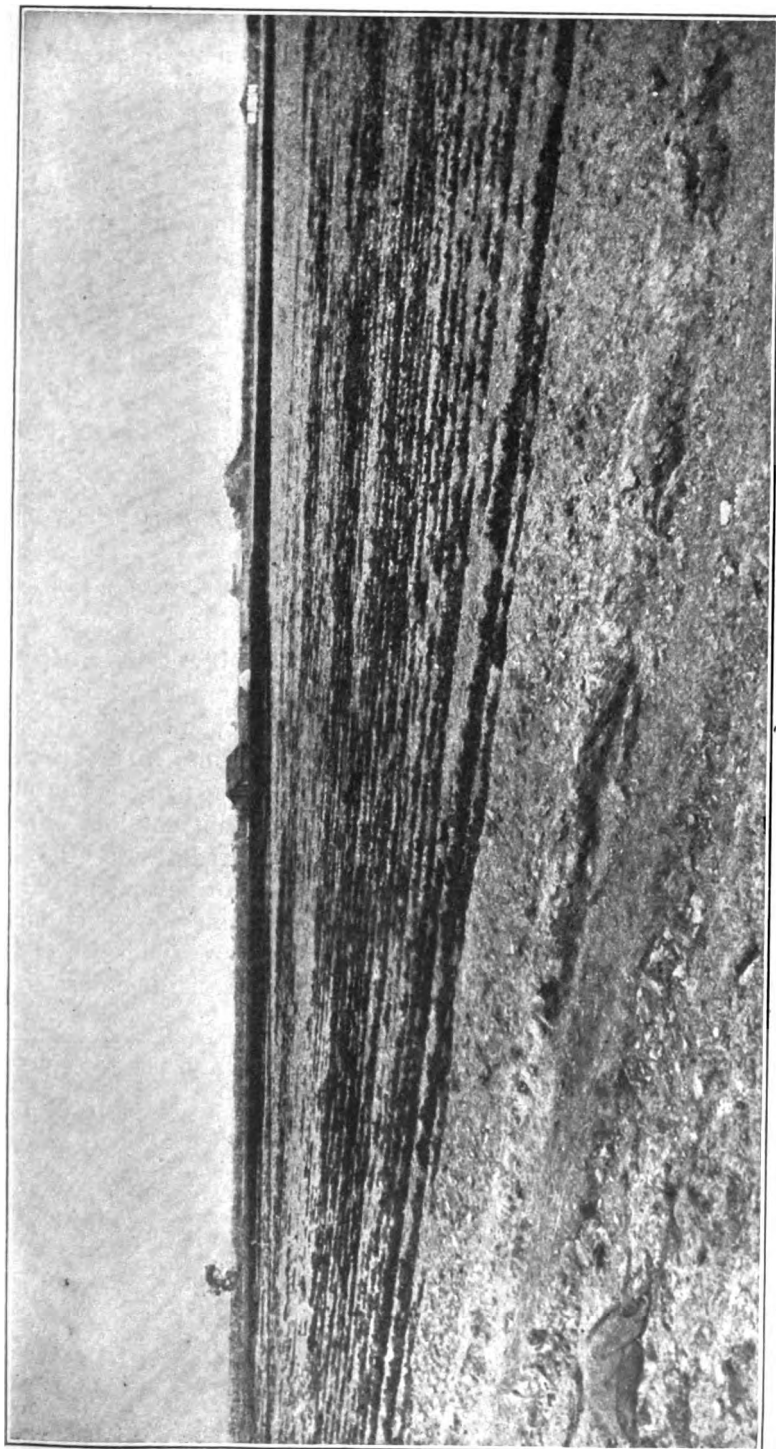


FIG. 6.—Sugar-beet field showing injury by beet leaf-beetle.

feeding for from three to four weeks before entering the ground to pupate. The pupa stage lasts 8 or 9 days. During September the beetles leave their food plants and go into winter quarters.

NATURAL ENEMIES.

Ladybird beetles of three species devour the eggs of this insect.⁶ A bug⁷ feeds on the larvæ and beetles. Mites and spiders also attack it, as does a fungous disease.⁸ Wild birds of several species prey upon it and chickens feed readily on the beetles and have been utilized to advantage in destroying this leaf-beetle.

CONTROL MEASURES.

Taking advantage of the fact that the beetles pass the winter in alkali areas under tufts of grass, especially "tickle grass," dead weeds, and other rubbish, it is possible, by thoroughly burning these during the winter, to destroy the beetles in great numbers, as has been practically demonstrated. They may be trapped by placing heaps of weeds or bunches of straw or hay in these alkali areas which they frequent, and after they have gone into hibernation, the traps with the beetles are destroyed by burning. If this is done thoroughly, immense numbers may be destroyed, but careless, slipshod work will invariably fail to produce the desired result. The best time for this work is between the middle of November and the first week of March, when the dead grass and weeds may be easily burned.

Thorough tests with arsenicals and other insecticides have been made but without perfectly satisfactory results, neither dusting nor spraying being entirely effective.

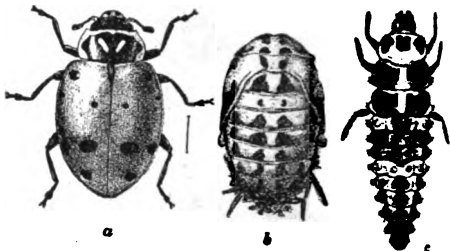


FIG. 8.—The convergent ladybird, an enemy of the beet leaf-beetle. Enlarged.

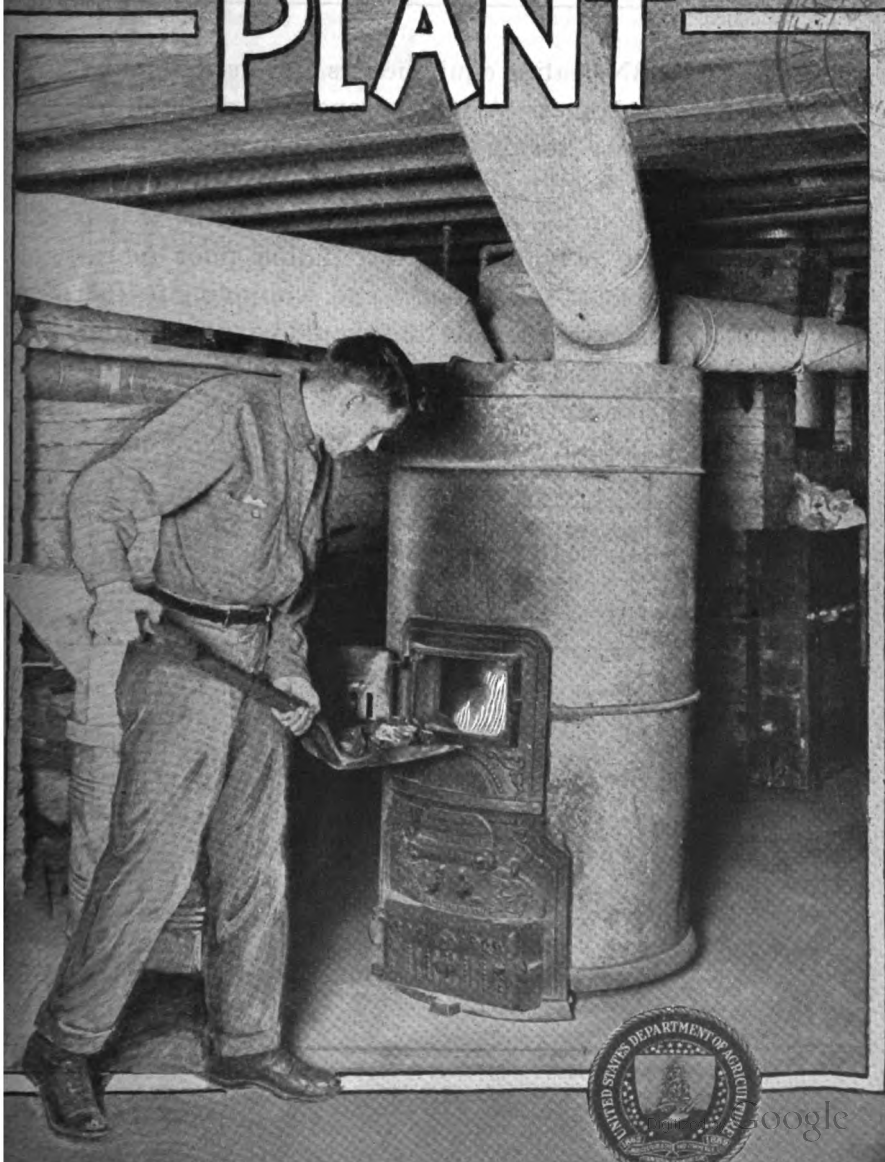
⁶ The most useful are *Hippodamia convergens* Guer. (fig. 8), *H. sinuata* Muls., and *H. glaciata* Fab.

⁷ *Perillus bioculatus* Fab., var. *claudus* Say.

⁸ *Botrytis bassiana*.

41.9:1194
FARMERS' BULLETIN 1194
UNITED STATES DEPARTMENT OF AGRICULTURE

OPERATING A HOME HEATING PLANT



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MODERN heating equipment is now used in many farm homes. A large proportion of these installations are burning more fuel than they should or are not heating the house satisfactorily. This may be due to the selection of a plant of the wrong design, size, or type, faulty installation, poor operation, or to loose-fitting doors and windows. In this bulletin the requirements that should be met in order to heat the home satisfactorily are discussed and advice is given concerning the selection, installation, and operation of home-heating plants.

Contribution from the Bureau of Public Roads

THOS. H. MacDONALD, Chief

Washington, D. C.

March, 1921

OPERATING A HOME HEATING PLANT.

By A. M. DANIELS,

*Assistant Mechanical Engineer, Division of Agricultural Engineering,
Bureau of Public Roads.*

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REQUIREMENTS FOR SATISFACTORY HEATING.

THE satisfactory and efficient heating of homes requires, first, that the chimney flue be of the proper size and in the proper place; second, that a proper heating equipment be installed correctly; third, that the plant be understood thoroughly and operated in a manner to give the maximum return from the fuel consumed; fourth, that the house construction be so tight that heat is confined within and cold air kept out; fifth, that the air be kept humidified as near to the correct degree as possible; and, sixth, that fresh air be admitted either continuously or from time to time in sufficient quantity to obtain the proper carbonic acid diminution.

Atmospheric conditions in our homes are seldom maintained as they should be. Houses are often overheated. In most cases practically no thought is given to humidity or to air moistening. Physicians insist that an overheated house is unhealthy, and that colds, sore throats, coughs, and the tendency to be nervous and feverish may be attributed to continually breathing air having too low a moisture content.

To overheat a house is a wasteful practice. It means the consumption of more fuel than is necessary. It shows a lack of knowledge of the apparatus and of its proper handling, for which the owner pays in dollars and cents. In certain sections of our country climatic conditions often change rapidly from extremes of heat to extremes of cold. Under such conditions one can not be too well versed in the characteristics of his heating system.

To live in too dry an atmosphere promotes ill health and augments the doctor's bill. It means neglect of an important phase of home conditions—lack of appreciation of atmospheric conditions as found in nature. Statistics show that about one-third of all deaths in this country have been due to diseases of the throat and lungs. Fresh, clean, pure, humid air as found out of doors is the treatment generally prescribed for such ailments; and until we understand the advantage of properly humidified homes we must expect the recurrence of discomforts that largely disappear during the seasons when our doors and windows are kept wide open. While this bulletin applies particularly to homes heated by warm air, hot water, or steam plants, many of the suggestions apply equally well where stoves are used.

THE CHIMNEY FLUE.

Chimneys defective in construction or badly located cause many failures of heating systems. Air passes up the chimney flue with a spiral movement; therefore a round, smooth flue is preferable because it offers less resistance to the upward passage of the gases. For structural reasons and because of the increased cost it is not nearly so common as the square or rectangular flue. The square is preferable to the rectangular. Many chimney flues are not lined. That is a mistake. The first cost of a lined flue is greater, but the benefit is not only better furnace operation but continual fuel saving; moreover the danger of fire is lessened.

The most efficient chimney, as far as draft is concerned, is one built perfectly straight from the bottom up with a round or nearly round flue, lined with tile or having the interior surface made smooth by other means. There is no advantage in tapering the inside toward the top. The cross section and height are determining factors of efficient service. The transverse area must be sufficient to pass the volume of air required to burn the fuel properly, and the height must be great enough to produce sufficient draft and insure against interference by adjoining buildings or projections of the same building.

In a square or rectangular chimney the corners are dead. The effective area in square flues is 85 to 90 per cent, and in rectangular flues about 75 per cent.

Ordinary residence chimneys vary in height from 25 to 60 feet, their area being proportional to the size of the house. A chimney large enough for the draft may yet be too small, for no flue should be less than 8 inches in diameter or 8 inches square. Satisfactory results can be expected under ordinary conditions with warm air, hot water, or steam plants if the sizes given in the following table

are followed. The sizes given are the commercial designations, the actual sizes of the flues being a little less:

Flue sizes for residences.

Volume of building.	Size of flues.		
	Round.	Square.	Rectangular.
<i>Cubic feet.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>
20,000	8	8 by 8	6 by 10
40,000	9	9 by 9	8 by 12
60,000	10	10 by 10	8 by 14
110,000	12	12 by 12	10 by 18

SELECTION AND INSTALLATION OF HEATING EQUIPMENT.

The selection of the system to be purchased should be made with the greatest care and only after a thorough investigation of its suitability to the house for which it is intended.

Efficiencies of heaters, as advertised, have been determined under laboratory test conditions. Theoretically, when a selection is to be made the best results would be expected from the heater which shows the highest efficiency rating, and if it were possible to base a selection upon data secured under identical test conditions the test results would be a fair indication of the relative efficiency. But there are other factors that affect the results.

The term efficiency applied to the maintenance of inside temperatures or to economy of operation of house-heating equipment may be misleading. All heat energy made available by a heating apparatus is ultimately transmitted to the outer air. The walls of the building, the windows, doors, etc., interpose resistance between the heated space and the outer air. If these are poor conductors of heat then the resistance is relatively high, and a higher temperature will be maintained in the room with the same flow or radiation of heat than if they were good conductors, hence the efficiency of heating equipment can be but relative.

Consequently, the heating plant with highest efficiency for a particular house must be judged by service to the owner. It will be the plant that gives the best service at the least cost. As individual demands and requirements differ, so opinions of users as to results from different plants will differ. Adequate service is the first requisite. If several will give this then the selection depends largely upon the comparative cost. If the cost does not affect the selection, then reliability and convenience of operation should be the determining factors.

Do not rely upon the judgment, opinion, or experience of any one person unless that person is familiar with all equipments and un-

biased. Talk with owners of different plants, learn the disadvantages of their installation, and find out whether all the rooms are heated satisfactorily. If they are not, try to find out whether the fault lies in the unsuitability of the apparatus to the particular house or to improper installation or poor operation. If the owner seems satisfied, before you decide on similar equipment, assure yourself before placing the contract either that the plan of your house is essentially the same or that the system can give satisfactory results with either type of construction.

THE HEATER.

After deciding on the type of apparatus be sure that the heater is of sufficient size to heat the building easily in the coldest weather. Consider service above price and appearance. Make a selection based on reputation, economy of fuel, and attention required for operation. Examine the joints to see that proper provision has been made for contraction and expansion, see that the castings are well made, free from large blowholes, cracks, or other imperfections. Inquire whether the manufacturer is reputed a maker of good heaters.

INSTALLATION.

The best and highest-priced heater improperly installed may give less satisfactory results than the poorest and cheapest properly installed. Therefore consider well the competency of the man who is to do the work. He should have had experience in putting in similar equipment, should be one that is in touch with the manufacturer directly or through a representative; above all a man who takes pride in doing good work. Having made a wise selection, realize that it is the business of the contractor to put in a successful plant and to his interest. Therefore do not dictate to him unless you are prepared to assume responsibility for the result. If locations which he proposes do not agree with your wishes, make sure that your choice will not affect the results.

Heating contractors expect to guarantee that the apparatus will heat certain rooms to a definite temperature under specified outside conditions. The purchaser should ask for such a guarantee.

UNDERSTANDING THE HEATER AND OPERATING IT INTELLIGENTLY.

To warm a house at low cost the characteristics of the heater must be understood and it must be operated intelligently. One who looks upon every heating apparatus as merely a mechanical contrivance which he has but to fill with fuel and remove ashes from in order to provide comfortable rooms for his family will fail. Some

mechanical apparatus may be almost wholly automatic in its action, but a domestic heating apparatus is not in this class. Its action must be controlled and its functions to some extent directed. All persons can not be expected to understand the technical details of heating problems, but it is in the interest of every owner to become as familiar as possible with the operation of the heating plant upon which he depends during the winter months.

It is not enough to install a heater, fill the bins with coal, and then expect it to do the business. Nor can economy be practiced and proper temperatures be maintained if a servant that has no interest in the annual coal bill be given free rein.

Waste should be eliminated. The heat locked up in every pound of coal that goes into a heater should be extracted. The ash can should contain no combustible. If it is possible with a certain coal consumption to maintain a comfortable temperature, to burn more is extravagance and waste. The average house owner burns too much coal, principally because he does not know how to regulate his heater.

Heaters should be studied in relation to the work that they are to do. Every owner should know how to regulate his furnace so as to make it follow the changes in the outside temperature.

REGULATING DAMPERS.

In figure 1 the common location of dampers and checks is shown, although they are frequently placed in other places. While the illustration shows a warm-air furnace, the following explanation of the use of dampers applies equally well to any type. Four dampers should be provided. They are customarily referred to as the draft damper, the check damper, the feed-door damper, and the smoke-pipe damper. The draft damper is generally a lift door or slide in the ash-pit door through which nearly all the air that makes the fire burn is admitted. The check damper is usually located at some point in the smoke pipe, not necessarily as shown in figure 1. By opening this damper, cold air is admitted into the smoke pipe, interfering with the chimney draft, and retarding the burning of the fuel in the heater. This damper should be closed tight when fresh coal is added to the fire. It is convenient to have a chain connected to it and run through the floor above, so that it may be operated without making a trip below, though with this arrangement inspection of the condition of the fire is impossible and there is the chance that it will not receive the attention it should. The feed-door damper, consisting of a slide in the feed door, is of more importance than is usually supposed; through it cold air is admitted directly

over the fire; if opened wide it acts as a check, similar to the check damper; if the opening is properly regulated it admits just sufficient air to supplement that admitted through the draft damper, causing more perfect combustion of the fuel. The fourth damper, known as the smoke-pipe damper, is particularly valuable for a chimney with an exceptionally strong draft, as it gives more effective control than can be obtained with a check damper only, in windy weather or at night; this damper is frequently omitted, sometimes without detri-

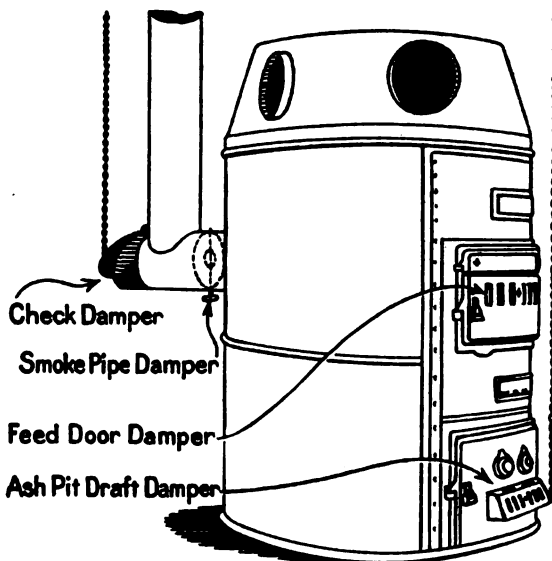


FIG. 1.—Location of furnace dampers.

ment, but it is best that it be provided, and it should always be placed between the furnace and the check damper and never between the check damper and the chimney flue.

Another damper, known as the hot-blast damper, is provided for soft-coal furnaces. This draft opening connects with an independent air chamber for admitting heated air above the fire. Its function is essen-

OPERATING THE DAMPERS.

When a fire is to be started, after preparing the firepot with light material and placing a little heavier wood on top, open the draft damper wide, close the check and the feed-door dampers, and set the smoke-pipe damper so that the wood fire burns briskly but not too fast. When the wood is burning thoroughly, throw on coal, spreading it well over the burning mass of wood. Do not put on too much coal at one time. See that the fire continues to burn well. If blue flames are noticed sprouting up over the coal when the feed door is opened, then open the feed-door damper to admit additional air to burn the gases that are being given off from the coal. When the blue flames disappear close the feed-door damper and permit the fire to burn up until the temperature of the house has about reached that desired. Then close the draft damper and open the check

damper until the fire seems to stand still. It may be found necessary to keep the draft damper slightly open. The owner should experiment with these two dampers to determine just how far each should be opened to hold the fire so that the desired temperature in maintained in the rooms.

When the fire is to be closed down for the night, after having thrown on fresh coal or banking cinders, close the check damper and open the draft damper, allowing them to remain so until gases cease to be given off, indicated by the disappearance of blue flames over the coals; then close the draft damper and open the check and the feed-door dampers. Sometimes it may be advisable to close the smoke-pipe damper completely. This must be determined for each installation, as it is dependent upon the chimney draft and the weather.

There is another factor that affects the damper operation. Different kinds or grades of coal require different quantities of air for combustion, and consequently a damper must be opened just wide enough to burn the coal most economically.

SELECTION OF FUEL.

Let it not be assumed that one grade of coal will be as satisfactory as any other. The best fuel, that which will require the least attention in burning, will be the most economical and will give the greatest satisfaction. Sometimes poorer coal may have to be used, as was the case in many domestic heating systems during the war, when transportation problems compelled the use of poorer grades.

Fuels for house-heating purposes may be mentioned in the order of their desirability as follows: (1) Anthracite coal in sizes commonly known as pea, buckwheat, chestnut, stove, egg, and furnace; (2) gas-retort or metallurgical coke in pieces one-half inch to 3 inches through; (3) coal briquettes, 2 to 3 inches in diameter; (4) screened Pocahontas (semibituminous) coal, over one-quarter inch and up to 3 or 4 inches in diameter; (5) sized bituminous coal in pieces one-half to 3 inches across. Although a good grade of hard coal is generally considered to be preferable to any other fuel for house-heating furnaces, coke may often be found to be more satisfactory than the grade of hard coal obtainable. The smallest size of coke, known as No. 2 nut, running from one-half inch to 2 inches, frequently may be purchased at a price below that asked for the usual furnace sizes, because of the popular impression that it can not be burned successfully on ordinary furnace grates. Investigations have shown this size of coke to be very satisfactory for heating houses and stores. A larger size does not lay so closely, and therefore frequently burns too fast, requiring more frequent firing. It is generally thought that this smaller coke is subject to heavy leakage through the grate bars into

the ash pit. Excessive shaking would probably produce this result, but a coke fire requires less shaking of the grate than a coal fire. In ordinary weather one shaking a day, preferably in the morning, is all that will be necessary. In very cold weather the grate may have to be shaken before each firing. Better results are obtained with little shaking, and the fire should never be shaken so much that pieces of hot coke fall into the ash pit. Therefore, as soon as sparks appear in the ash pit, stop shaking. Some who have burned coke for years claim better results from leaving a layer of ashes 1 to 2 inches thick on the grate all the time. The ashes check the draft and keep the hot coke from coming in contact with the grate. Although this size of coke clinkers rather freely, the clinker is soft and quickly breaks up. Clinkers should be removed while the fire is hot and before fresh fuel is put on, because under such conditions the ignited coke in the firepot is in a semiplastic state and when distributed by the removal of the clinkers merely settles down in the grate without falling through.

ATTENTION TO THE FIRE.

Generally speaking, comparatively little attention is given the fires in house-heating equipment. In some cases the fire is permitted to vary from one extreme to the other. No attention is paid to it until the house becomes uncomfortably cold or too hot. It should receive attention at regular intervals. Usually the man of the house will attend to it early in the morning, late in the afternoon, and just before retiring with more or less regularity. This enables him to study his fire and fuel and perhaps to judge the relative merits of different fuels used, providing he realizes that only by actual trial in his particular furnace under conditions of customary usage can he learn which fuel is best suited to his requirements.

It is impossible to state how often a fire should receive attention without knowing the actual conditions. The type of heating system has much to do with it. For instance, a hot-water heating system will maintain a far more uniform temperature with less attention to the fire than will a hot-air system. No definite rule can be laid down that will apply satisfactorily in all cases. Thus the attention given to the fire will govern materially the fuel to be used. It is well for every individual to devote the first heating season after installing a heating system to a study of fuels and their burning in his particular heater. Buy at least two kinds of coal at one time and experiment with each separately and mixed in varying proportions. Note their burning qualities, whether they catch quickly, how much ash is left, and what the condition of the ash is, whether one size filters through the grates unburned, whether another forms clinkers that are difficult to remove or fuses and forms a crust that

interferes with the draft. An intelligent owner will soon be able to tell the kind of fuel best suited to his conditions and can then buy accordingly.

A fire should not be shaken down more than three times a day. Generally twice will be found sufficient, in the morning and in the late afternoon. Unless the fire has been burning hard continuously, and fresh coal has been fed to it at frequent intervals, care should be taken not to shake too much. Do not shake live coals through the grate. In mild weather let an accumulation of ashes remain on the grate. Never leave ashes under the grate in the ash pit, but clean out immediately after shaking. The volume of the ash pit is designed to permit enough air to pass into and through it to burn the fuel properly and at the same time keep the grate-bars cool enough to prevent injury from overheating. If ashes are allowed to remain in the ash pit they prevent necessary air circulation, hinder combustion, and cause damage to the grates. Figure 2 shows a set of grate bars removed from a furnace in which ashes had been allowed to accumulate. Note the warping and bending and how too little air will cause the iron to melt.

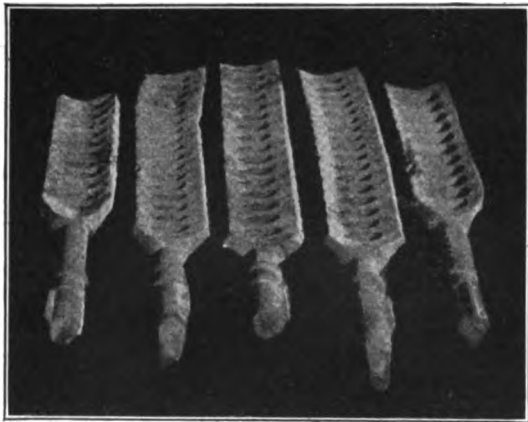
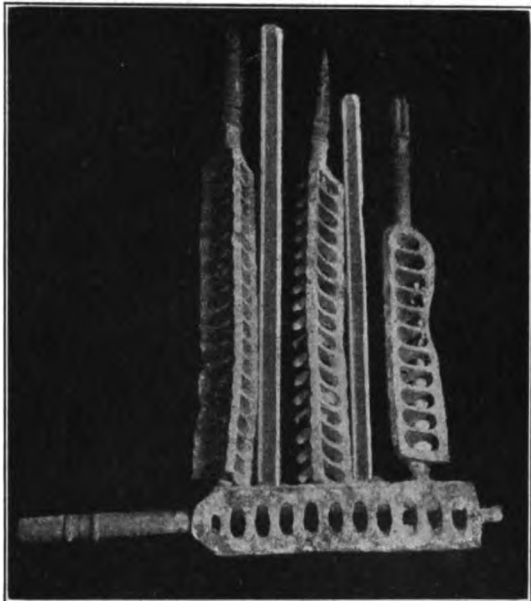


FIG. 2.—Grate bars warped and bent, due to allowing ashes to accumulate in the ash pit.

Do not shake down a fire until it has had time enough to catch. When first attending the fire in the morning it is well to open the

smoke-pipe draft damper and the ash-pit draft damper, throw on a little fresh coal, and allow it to catch well. When it is glowing, or, if one is in a hurry, after the blue flames have stopped flickering through the fresh coal, shake the grate back and forth with a short, quick movement. Do not turn the grates completely over unless it is necessary to remove a large clinker. As soon as the first bright spot is seen through the grate, stop shaking and clean out the ashes, sprinkling them if possible before handling. A small watering pot kept near the furnace assists materially in keeping down dust.

Disturbing the fire by poking or upturning is advised against wherever it will catch up and burn properly if given time. There are occasions, however, when it becomes absolutely necessary to use a poker. Caking or fusing coal demands attention to prevent the formation of a fused noncombustible mass directly over the grate. Considerable trouble from this cause has been experienced by the



FIG. 3.—Caking coal forming a hard fused mass directly over the grates that practically stops the draft.

writer. It was found necessary when the fire was permitted to burn steadily to turn the fire almost completely over twice a day to avoid having to dump it through the grates and rebuild the fire. A mixture of stove and pea anthracite coal had given the most satisfactory results with the least attention. Conditions due to the war made it impossible to

obtain the usual grade of these two sizes of coal, with the result that frequent overturning of the fire was necessary. The coal fused and formed a noncombustible mass directly over the grate, as illustrated in figure 3. Unless broken, this covering would so close the draft as to put the fire out or prevent it from burning sufficiently to give heat. Rocking the grates would sometimes break the fused mass, but not always. Sometimes the grates could be revolved with no effect other than to raise the whole mass. It then was necessary to use a poker through the fire door and break the mass by punching a hole through it and lifting the whole fire until the noncombustible mass was brought to the top, where it could be broken to pieces and removed through the fire door. Pieces 15 inches long and 3 inches thick were removed. Samples are shown in figures

4 and 5. The pile (fig. 4) with a 4-foot rule shown in front of it represents an accumulation of 10 days. Until this method was adopted it was necessary to clean the fire completely out about every sixth day. However, if it is resorted to, there must be a good fire on top of the mass. Unless it is turned over before the draft has

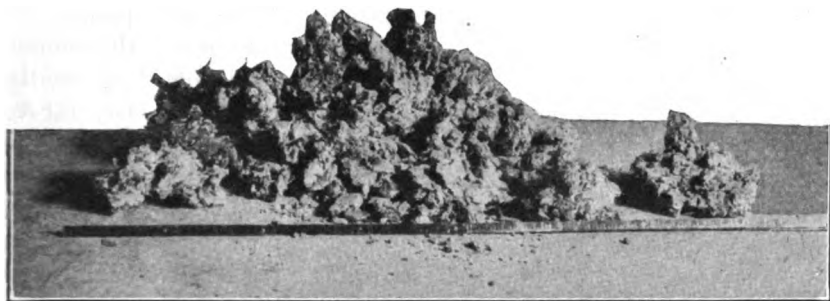


FIG. 4.—Fused noncombustible matter removed through the fire door. This had to be broken daily, the fire overturned, and the clinker removed.

been cut off enough to permit free burning the fire will need to be coaxed with wood, but by having a good bed of live coals when the overturn is made practically no harm will result to the fire. The writer has maintained his own furnace fire for months without permitting it to go out, at the same time heating his house with less

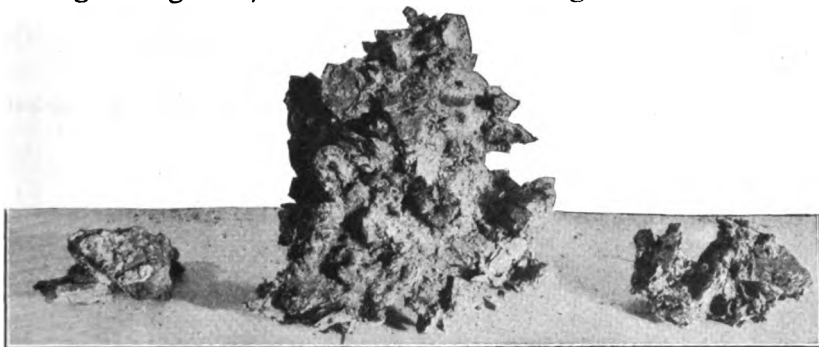


FIG. 5.—Samples of fused combustible formed from a mixture of equal parts of pea and stove size coal in a domestic heater. The largest of these pieces measured 12 by 16 inches.

fuel than neighbors burned with the identical heating system in exactly similar houses.

WEATHER-TIGHT HOUSES ESSENTIAL TO ECONOMICAL OPERATION OF A HEATING PLANT.

WINDOW AND DOOR LEAKAGE.

A change of air in all occupied rooms is essential to health. In residences one complete change an hour is usually considered ade-

quate, and calculations are so figured. Under conditions of moderate temperature and wind in houses of ordinary construction the air change through window and door cracks is not objectionable. Neither does it materially affect the operation of the heating plant. But when snow or rain is driven before a wind of 25 to 60 miles an hour if window and door cracks permit not one air change per hour but often as many as five, so that the atmosphere in the rooms, especially on the windward side, is many degrees below that usually maintained, then it is that the heating plant is often taxed beyond its capacity. Some rooms possibly are then closed off from the rest of the house, and an attempt is made to throw a maximum quantity of heat into one or two rooms—a practice altogether too prevalent. Remedies are numerous; the following may be mentioned: (a) Storm sash; (b) wood and felt weather stripping; (c) strip felting; (d) metal weather stripping; (e) calking compounds.

STORM SASH.

Storm sash provide an air space between the two layers of glass. This air space has an insulating value which reduces the effect of the cold outside air both as regards chilling the heated air in contact with the glass and leakage around the inner sash. Popular and useful as they are, many persons nevertheless object to their unsightliness. If fixed the value of the window for ventilation is lost; but the sash should be as air tight as possible when completely closed. A home-built one that permits opening at either the top or the bottom on a warm winter day is shown in figure No. 6.

WOOD AND FELT WEATHER STRIPPING.

Wood and felt weather stripping when put on properly aids materially in keeping out cold air. It should be applied on the outside at the opening between window sash and frame for the upper sash and usually to better advantage on the inside for the lower sash. When applied to windows or doors the felt should be placed in such close contact that more than ordinary effort is required to move the window sash and that the door must be pushed hard in order to lock it. Wood and felt stripping may also be used between the frame and wall where the wall line is not too irregular to completely close any crack there. Placed at the bottom of outside doors, wood and felt stripping aids materially in reducing drafts along the floor, a frequent source of colds in young children. The stripping should be attached to the outside of doors opening inward. Drafts under interior doors may be stopped in a similar manner. When first applied this stripping is highly efficient, but may not long remain so.

It tends to loosen from sliding sashes, while continual opening and closing of doors bends the felt back and forth, reducing the stiffness, so that it fails to close the crack completely. To secure the best results from its use on sliding surfaces, it should be reapplied every year, while that used on the bottoms of doors should be inspected and reset when it becomes less efficient. Many object to its unsightliness whether it be put on the inside or the outside.

STRIP FELTING.

Strip felting may be used like the wood and felt stripping. If the wall line adjoining the window or door frame is irregular, the crack

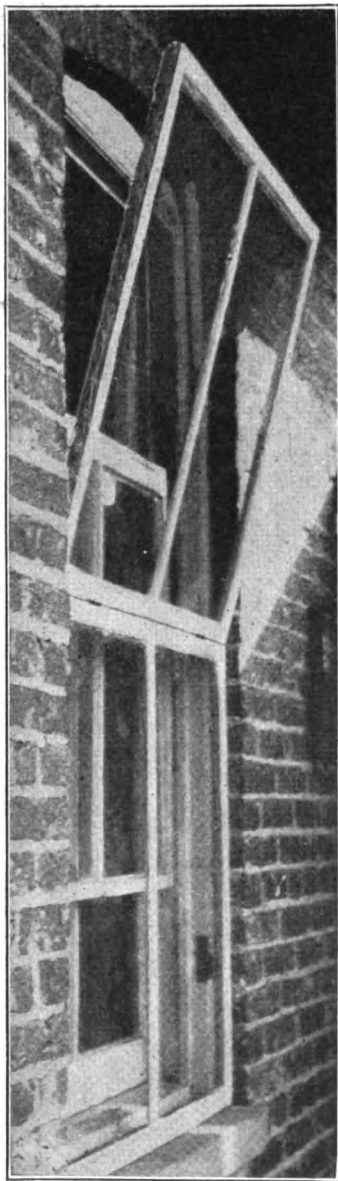
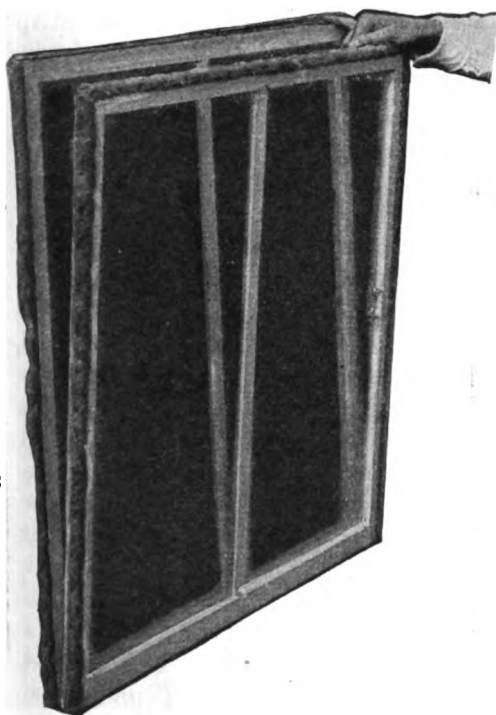


FIG. 6.—Home-built storm windows. By constructing the outer window in two parts and hinging them in the middle, rooms may be ventilated from above or below. Felt is tacked to the inner and side surfaces in order to make a tight joint, and the sections are held in place by screw hooks and eyes on each side.

may be closed satisfactorily with strip felt. It may be forced in until it is flush. This affords a more sightly appearance than

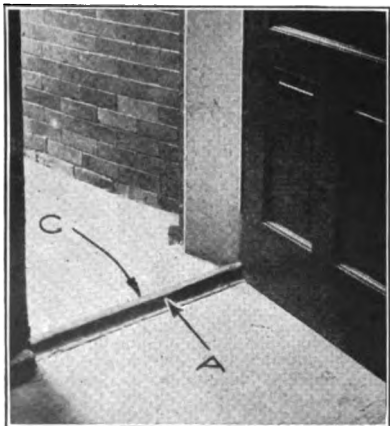
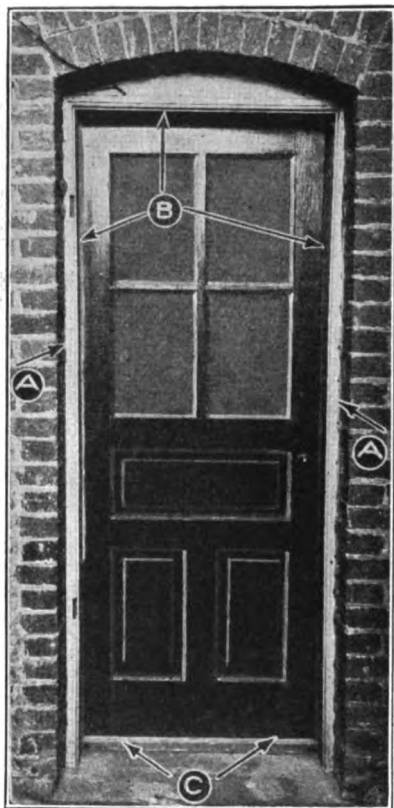


FIG. 7.—Strip felt and wood and felt weather stripping used to advantage in closing cracks. A represents felt tacked so as to cover the crack; B shows location of wood-felt nailed to the frame; and C is a block of wood covered on two sides with felt, placed so as to leave no crack under the door.

where wood and felt stripping is used. As a temporary expedient during short periods of high winds and low temperatures, strip felting may be used on the inside of all windows to close cracks by tacking it around the frame so that it rests against the sash. Thumb tacks mar less than carpet tacks and are more easily removed. Strips of this felt on the sill where the lower sash rests, at the top where the upper sash closes, and along the meeting rail aid materially. It can also be used to close cracks under doors. Note the door shown in figure No. 7. At A strip felting was tacked to the frame and then wedged between the brickwork and door framing. Ordinary wood and felt weather stripping was nailed to the frame, so that when the door is closed no crack is left. To close the crack at the bottom two sides of a strip of wood about one inch square were covered with felt and the strip was placed as shown at C, figure No. 7, and held by a small angle iron and screws on each side. In the above manner all cracks around this door were so effectively closed that no water leaked into the cellar when it stood 12 inches deep in the areaway outside during a heavy downpour. This method of closing the crack under the door may be condemned by some on the score that it forms a stumbling block. The one shown in figure No. 7 has been in place two years with two children between the ages of 4 and 7 using

the passage continually. Neither as yet has stumbled over the block. While strip felting may be used for advantage and in some instances in a more or less permanent fashion, yet it must in general be considered a temporary expedient. Its unsightly appearance and the tack holes that are left are a disadvantage.

METAL WEATHER STRIPPING.

Metal weather stripping has shown itself a very efficient means of reducing crack leakage and thus a material aid in making a house weather tight. It is now obtainable in a variety of forms. To install it the window sash must be removed and grooves cut to receive the metal strips. When the work is properly done most of the stripping is hidden and the exposed part has a neat appearance. The work is usually done by an experienced workman, although handy men sometimes buy the stripping and install it themselves. Metal weather stripping should be permanent; it should allow easy movement of sashes and at the same time effectually prevent the passage of air. Atmospheric conditions causing swelling or shrinkage of frames should have no effect upon its behavior. While beneficial results from it are recognized, the greater cost limits its use.

CALKING MATERIALS.

Calking compounds are used to insure against air leakage between the window or door frames and the stone, brick, or concrete of the building. Temperature, moisture, and indeterminate causes make for expansion, contraction, and settling. A joint of cement, mortar, or other solid material is hardly practical. The space may be closed with oakum or other calking material forced into the opening. A good calking compound for this use should have the property of expanding as the crevice widens and contracting as the crevice narrows.

LEAKY FLOORS WASTE HEAT.

Uninsulated floors will cause waste of heat. Moreover, cold drafts sweep across them, making the room an unfit place for anyone to sit. Cellars are the best guarantee of warm floors, but, if conditions make it difficult or perhaps impossible to have a cellar, a coat of plaster between the rough and finished flooring will help to make a very tight and warm floor. Heavy insulating paper can be used with the same result, and sealing the joints with lath and plaster or wall board will do.

PIPES AND HOT-AIR DUCTS SHOULD BE INSULATED.

Another important aid in economizing heat is the insulation which should be provided for the steam or hot-water pipes or warm-air ducts. Standard makes of pipe coverings will effect a saving in coal. By all means cover all pipes that are in exposed positions. In one home where hot-air ducts were placed against the north wall no heat could be obtained from the register until the space around the duct was packed with insulating material.

EFFECT OF CRACK OPENINGS IN WINDOW LEAKAGE.

The clearance between window sashes and frames and between doors and frames varies from $\frac{1}{16}$ to $\frac{3}{32}$ inch; in poor construction the opening may be as much as $\frac{1}{8}$ to $\frac{1}{4}$ inch. A clearance of $\frac{3}{32}$ inch is quite usual. With a wind velocity of 15 miles per hour this opening of $\frac{3}{32}$ inch would permit the passage of about $1\frac{1}{2}$ cubic feet of air every minute for every linear foot of crack around the window. An ordinary double-sash window (36 inches wide by 72 inches high) would admit about 30 cubic feet of air per minute. With $\frac{1}{16}$ inch clearance 20 cubic feet per minute would be admitted.

The effect of this leakage upon the heating of the room may be serious. A room 10 feet wide by 20 feet long, with a ceiling 10 feet high, contains 2,000 cubic feet of air. Assuming that the longer side is exposed to the north or west, and that there are two windows with $\frac{3}{32}$ -inch clearances, and assuming that the air is to be changed completely once each hour, which is customary for residential plants, it would require 2,900 heat units to raise the temperature from 0° to 70°, with the wind blowing at 15 miles per hour. The air leakage through the clearances around the sash would be about 3,650 cubic feet per hour, or one and eight-tenths times the cubical measurement of the room. To heat this quantity of air about 5,300 heat units would be required, or approximately 80 per cent more than that required for one complete change of air per hour. If the wind velocity be 30 miles per hour the leakage would be doubled and there would be required three and one-half times the number of heat units needed for one complete change per hour.

Tightly fitting windows will improve these conditions. If the crack opening were one-sixteenth inch, then, instead of 80 per cent more than the designed capacity being required, the additional heat units would be about 22 per cent.

The advantage to be derived from good construction will be appreciated in the comfortableness of the room and realized in the fuel saving. More fuel is invariably consumed in a house with loosely

fitted windows than in one where the clearance is reduced to a minimum. Increased fuel consumption is seldom adequate to correct faulty construction, particularly on windy days.

EFFECT OF USING METAL WEATHER STRIPPING.

As pointed out, tight-fitting windows are essential if leakage losses are to be kept down. Ordinary felt weather stripping helps to reduce this loss. Metal weather stripping is still better and aids materially toward an annual saving of fuel. Some tests have demonstrated that it is possible, by the use of metal weather strip, to reduce by 88 per cent the leakage through a one-thirty-second inch crack with a wind velocity of 15 miles per hour and by 83 per cent with a 30-mile wind.

The condition of the windows in a building, whether tight, loose, or loose enough to rattle, plays a very important part not only in the comfort derived from a heating plant but more noticeably in the annual cost of operation. Suitable metal weather stripping frequently reduces by 15 to 20 per cent the radiation required.

The prevention of window leakage means a saving of heat and a lessening of dirt blown into the house. In a certain apartment house, situated near a railroad station in a large city, during the first season of its occupancy the heating system supplied sufficient heat with a reasonable economy of fuel, but smoke and dust were a nuisance. Metal weather stripping was applied before the next heating season, and as a result the temperature of the rooms was too high. The radiating surface was reduced almost one-fourth, and it still supplied sufficient heat, while the fuel consumption also showed a noticeable reduction. Fuel saving of 15 to 25 per cent appears possible by equipping windows and doors with metal stripping. If, therefore, metal weather stripping is put in when the house is built, it is possible to reduce the size and cost of the heating plant proportionately to the reduction in radiation surface made possible. The cost of metal weather stripping may frequently be offset by the reduction in cost of the heating plant.

HUMIDITY.

It is now recognized that in addition to maintaining the proper temperature in an artificially heated house another factor of great importance is humidity, or the moisture that is present in the air. All air contains moisture in varying amounts, depending upon locality and temperature.

The rate of evaporation from the body determines susceptibility to heat and cold. Temperature and humidity largely determine this. In the southwest section of our country, where the air is relatively

dry, the evaporation, being high, produces a cooling effect and we are able to stand a comparatively high temperature. In the north middle section, where the relative humidity is comparatively high, a very low temperature is far less objectionable than where the temperature and humidity are both low, for in the former case high humidity hinders bodily evaporation, and therefore lessens the cooling effect, while in the latter the cooling effect of evaporation augments that due to the low temperature. A pleasant and healthful atmospheric condition should be our aim, and this may be secured by reproducing as nearly as possible within our houses one that approximates a proper humidity for the temperature maintained.

Open windows at night cause a higher average humidity in the house. This produces a soothing effect upon tired nerves, supplies more healthful air, and causes dust to deposit on the floor instead of floating to be breathed. One hundred years ago 50° to 55° was considered a good house temperature. Fireplaces were used then. During the era of stoves, about 70 years ago, 62° was considered satisfactory. Thirty years ago, with furnaces in greater use, a temperature of 72° was maintained, while now a temperature of 70° is considered standard, although it is not unusual to find steam-heated homes maintained at temperatures still higher. Dry air is likely to be dusty air. Dusty air is an irritant. Notice the dust betrayed by a sunbeam. When air within a house is heavily laden with dust the relative humidity is most likely to be very low. The floating particles are carried into the lungs. It were better to deposit these impurities on the floors and furniture. By increasing the relative humidity of dusty air in a room from 25 to 50 per cent, the floating particles in the air may be materially reduced. The best conditions of temperature and moisture for health have not as yet been definitely established. It is not unlikely that varying degrees of each, somewhat approximating outdoor conditions will be found best. At present some authorities state that a temperature of 68° F. with relative humidity between 40 and 50 per cent is about right. O. W. Armspach¹ from a comparison of 3,612,000 deaths with the corresponding weather conditions in the cities where the deaths occurred, has prepared a curve showing the proper temperature to be maintained for various percentages of humidity. The curve is reproduced in figure 8. Mr. Armspach says:

The ideal temperature [wet-bulb] for physical health lies between 57 and 61°. Any variation above or below this limit has a marked effect upon health, a variation of 2° resulting in an increase in deaths of about 2 per cent.

A dry-bulb temperature of about 70° and relative humidity approximating 20 per cent—a condition that is not unusual in many

¹ Author of *The Relation of Wet Bulb Temperature to Health* published in the *Journal of the American Society of Heating and Ventilating Engineers* for May, 1920.

homes in winter—corresponds to a wet-bulb temperature of $50\frac{1}{2}^{\circ}$, and according to Mr. Armspach increases the death rate about 6 per cent above what it would be if the wet-bulb temperature were 57° .

RELATIVE HUMIDITY.

The moisture-carrying capacity of air depends on its temperature. Warm air has a much greater capacity for moisture than cold air, although it may feel drier. It is the relation between the actual amount of moisture in the air at a given temperature and the amount of moisture that the air could hold at that temperature that causes it to feel dry or moist.

Consider a piece of cloth held in a vertical position and sprinkled with water. No water will drip from the cloth until it is completely saturated, holding all the water that it is capable of holding. So it is with air. When the air is so laden with moisture that water is deposited in the form of dew the air has reached the point of complete saturation, known as the dew point. Then the relative humidity is 100 per cent. If

air contains seven-tenths as much water as is present when it has just reached the dew point, its relative humidity is 70 per cent. If a room having a temperature of 40° with air at 70 per cent relative humidity be warmed up to 70° , the percentage of saturation decreases with the increase of temperature, since the warmer the air the more moisture it is capable of holding in suspension. Unless more moisture is added as the temperature is increased the percentage of saturation will be reduced, so that whereas the air at the lower temperature held seven-tenths as much as it was capable of holding, under the higher temperature it holds only two-tenths as much. Then its relative humidity would be 20 per cent.

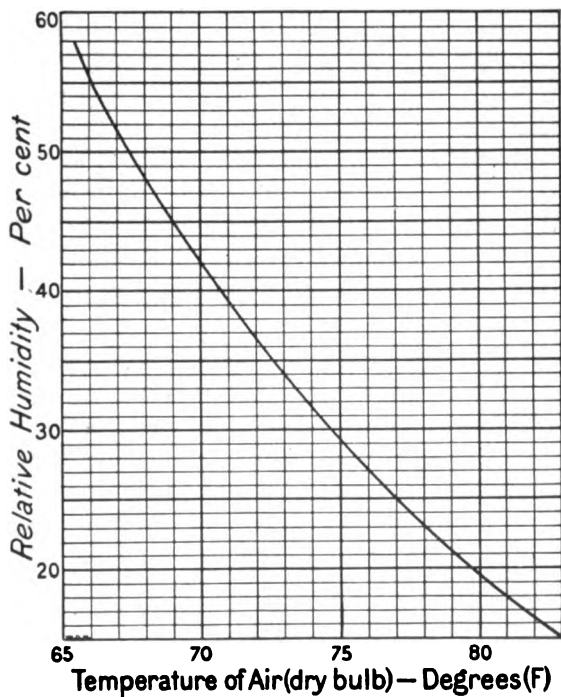


FIG. 8.—Temperature-humidity curve.

There is little doubt but that in most dwellings during the heating season the air is drier than is best for health and comfort. The relative humidity is too low. A room in which the air is properly humidified will be more comfortable at a lower temperature than one in which the moisture content is too low.

Our bodies are cooled by evaporation from them. If the body be surrounded by very dry air evaporation will take place rapidly and produce a cooling effect so that a person feels cold. If the body be surrounded by moist air evaporation takes place more slowly, the rate of evaporation is less, and a person feels warm though the actual temperature of the air may be lower. Too much moisture with heat is equally unpleasant, producing a muggy feeling, quite noticeable in some parts of the country where high humidity with high temperature prevails for long periods.

It is not believed that any investigations have proved definitely what are the best conditions as to temperature and moisture for our dwellings. Seventy degrees F. is generally taken as the standard temperature for living and other rooms in which the occupants are inactive, excepting sleeping rooms. It is thought that for this temperature a humidity between 40 and 50 per cent should be maintained. It should not be less than 30 per cent, whereas it is probable that were the humidity in our houses tested it would be found usually to be 20 per cent or lower. That is as dry as desert air and predisposes persons that breathe it to throat and nose irritations. The drier the air the more difficult it is to heat a house with it. The moisture in the air carries and retains heat. In cold weather a considerable quantity of moisture is required if the humidity is to be kept up.

MOISTURE REQUIRED TO MAINTAIN HUMIDITY.

Consider an average-sized house containing a family of five persons. Each person requires 1,800 cubic feet of air per hour; so 9,000 cubic feet ($5 \times 1,800$) must be provided for the occupants every hour. Cracks around windows and doors or the opening of doors and windows are usually depended upon to supply the needed air where a steam or hot-water heating system is installed. If a warm-air pipe furnace is used the fresh-air duct will take care of it. If air at 0° temperature and 70 per cent relative humidity is introduced into a house and heated to 70° F. and during the temperature rise no moisture is added the relative humidity will decrease 65.91 per cent to 4.09 per cent. That is entirely too low.

Assume that the temperature is to be maintained at 70° F. and the relative humidity at 40 per cent, which is not too high. In order that those values be kept for 9,000 cubic feet per hour there would

be required an evaporation every hour of almost one-half gallon of water. Not many existing plants are capable of approximating that quantity.

HOW TO DETERMINE HUMIDITY IN A ROOM.

A rough practical test for determining whether the air in a room is too dry is to observe the inside of windows on a cold day. If frost forms freely on the inside of the glass there is no doubt but that the inside air has sufficient humidity. If there is no sign of frost the air is likely too dry.

If a more accurate test is desired it may be performed with two thermometers in the following manner: Use thermometers that have their bulbs completely exposed. Around the bulb of one tie a small piece of cheesecloth or other porous fabric and thoroughly saturate it with water. Whirl this wet-bulb thermometer around on the end of a string 12 to 15 inches long. The height of the mercury in this thermometer will fall rapidly, owing to the evaporation of the water from the little sack surrounding the bulb. The drier the air the faster the mercury will fall. After two or three minutes, the wet-bulb temperature will become stationary. A reading should be taken instantly to obtain the low point. The dry-bulb thermometer reading should be taken simultaneously. Subtract the wet-bulb reading from the dry-bulb reading and refer to the accompanying table, from which a value for the relative humidity may be obtained.

The experiment can be performed with one thermometer by taking the average room temperature before using it as a wet-bulb thermometer.

TO USE THE TABLE.

Suppose, with the dry-bulb temperature at 70° F., that the wet-bulb temperature became stationary at 56° F. The difference between the two is 14°. Refer to the table and follow down the first column on the left to 70, then follow the horizontal line until the vertical column 14 is reached, and read the relative humidity, 40 per cent. For ordinary living rooms with temperatures of 68° or 70° the relative humidity should be between 30 and 50 per cent.

With the help of the table it should be an interesting experiment to determine the temperature to be maintained when the humidity is about what it should be; 40 per cent might be taken as a standard to work toward. Very probably the temperature in many houses has been maintained at 70° and above when it could be lowered were the relative humidity kept up to the proper value.

Reading of dry bulb thermome- ter (de- grees F.).	Difference between dry and wet bulb (degrees F.).																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	Relative humidity (per cent.).																				
60.....	94	89	83	78	73	68	63	58	53	48	43	39	34	30	26	21	17	13	9	5	1
61.....	94	89	84	78	73	68	63	58	54	49	44	40	35	31	27	22	18	14	10	7	3
62.....	94	89	84	79	74	69	64	59	54	50	45	41	36	32	28	24	20	16	12	8	4
63.....	95	89	84	79	74	69	64	60	55	50	46	42	37	33	29	25	21	17	13	10	6
64.....	95	90	84	79	74	70	65	60	56	51	47	43	38	34	30	26	22	18	15	11	7
65.....	95	90	85	80	75	70	66	61	56	52	48	44	39	35	31	27	24	20	16	12	9
66.....	95	90	85	80	75	71	66	61	57	53	48	44	40	36	32	29	25	21	17	14	10
67.....	95	90	85	80	75	71	66	62	58	53	49	45	41	37	33	30	26	22	19	15	12
68.....	95	90	85	80	76	71	67	62	58	54	50	46	42	38	34	31	27	23	20	16	13
69.....	95	90	85	81	76	72	67	63	59	55	51	47	43	39	35	32	28	24	21	18	14
70.....	95	90	86	81	77	72	68	64	59	55	51	48	44	40	36	33	29	25	22	19	15
71.....	95	90	86	81	77	72	68	64	60	56	52	48	45	41	37	33	30	27	23	20	17
72.....	95	91	86	82	77	73	69	65	61	57	53	49	45	42	38	34	31	28	24	21	18
73.....	96	91	86	82	78	73	69	65	61	57	53	50	46	42	39	35	32	29	25	22	19
74.....	96	91	86	82	78	74	69	65	61	58	54	50	47	43	39	36	33	29	26	23	20
75.....	96	91	86	82	78	74	70	66	62	58	54	51	47	44	40	37	34	30	27	24	21
76.....	96	91	87	82	78	74	70	66	62	59	55	51	48	44	41	38	34	31	28	25	22
77.....	96	91	87	83	79	74	71	67	63	59	56	52	48	45	42	39	35	32	29	26	23
78.....	96	91	87	83	79	75	71	67	63	60	56	53	49	46	43	39	36	33	30	27	24

[Table based on 30 inches barometric pressure.]

SUPPLYING MOISTURE TO THE AIR.

Aside from the increased comfort and healthfulness secured from properly moistened heated air the saving in fuel through moistening should not be overlooked. It is estimated that 25 per cent of the cost of heating is expended in raising the temperature within a house from 60° to 70°. The conclusions of Mr. Armspach indicate that the best temperature for physical health lies between 57° and 61° (wet bulb) provided the relative humidity is maintained between 65 and 75 per cent. If his conclusions be correct, then it is possible to save fuel and yet be comfortable at a temperature below that commonly thought to be required. To do so, however, means must be provided for evaporating more water. To do this requires either a large evaporating surface, a high temperature, or both.

There are several methods by which moisture may be added to the air supply of a warm-air furnace-heating system, although it is doubtful whether any at present are capable of supplying sufficient vapor to maintain high enough relative humidity to permit a room temperature much below 70°. The common practice of placing a small cast-iron receptacle, called the water pan, in the side of the furnace casing is but a feeble effort in the right direction. It is seldom, if ever, large enough or has sufficient surface, while in many cases the pot is so placed that no appreciable amount of water can be added to the passing air. A small water pan set low down in the furnace has practically no effect. It should have a large area and be set well up into the warm-air space, so as to

make evaporation as rapid as possible. The pan should be heavy enough to stand rusting. It should be placed over the combustion chamber with its bottom at least 2 inches above the top. A supply pipe with ball stopcock and an overflow pipe make it easy to keep the pan filled with water. With a pressure water system automatic control is possible; the quantity of water evaporated increases with the quantity and temperature of the air passing through the furnace, so that the humidifying apparatus to some extent is self-regulating. A very effective pan may be made by riveting and soldering a strip of galvanized iron around the inside of the top casing directly under the openings for hot-air leader pipes. The ring should be from 2 to 2½ inches wide, with the inside edge turned up about three-quarters of an inch. A little cup riveted on the outside of the casing with small holes drilled through the casing permits hand filling, or a permanent supply pipe can be connected.

If there is a cold-air chamber a satisfactory humidifier may be provided by building a galvanized iron and wire rack with two or three sloping shelves to hold crushed coke. Insert a perforated pipe so that small streams of water will play upon the coke on the top shelf and trickle down through the ones below, thus keeping the coke continually wet. A drip pan at the bottom connected with an overflow pipe leading to a drain completes the apparatus. Another method is to spray the incoming air by means of several small atomizers arranged in the cold-air duct with a proper outlet for the overflow. Moist air absorbs heat better than dry air; otherwise it makes little difference whether the air is moistened before or after it is heated. Several commercial humidifiers for spraying the heated air as it leaves the furnace are also obtainable. Very satisfactory humidification has been secured with the better types.

So far as known no one has yet devised a satisfactory method of moistening air in houses heated by hot water. Pans which hang on the back of the radiator are obtainable, but they do not have a large surface, and as they are not highly heated they are not very effective. Sheets of asbestos or blotting paper placed directly beneath the pans with one or more needle holes punched in the bottom adds to their effectiveness, as the paper absorbs the water and increases the evaporating surface. The objection to this arrangement is inability to control the flow of water. Wicks or an apron of absorbent material hanging down back of the radiator with one end resting in the water pan will draw up water by capillary attraction, and the air movement around the radiator will evaporate it and carry it off into the room.

Water pans are little more effective with steam than with hot-water radiators. Provision is sometimes made to discharge steam

slowly into the room direct from the radiator. This proves much more effective where there is steam pressure, but many dislike the noise and odor of the escaping steam.

VENTILATION REQUIREMENTS.

Air confined within an occupied room or building becomes foul and unfit for breathing. Fresh air is necessary to sustain life. Ventilation consists in the natural or mechanical displacement of vitiated air and its replacement by fresh air. Complete renewal of air can not correctly be said to occur any given number of times in an hour, since a total change does not actually occur. What does happen is that the incoming air mixes with and dilutes the foul air to a point suitable for healthful respiration.

When air is taken into the lungs it has the temperature of the room, but when expired its temperature is 90° to 98°. It is also nearly saturated with water vapor and is from 1 to 3 per cent lighter. These, however, are not the greatest changes. Air is composed essentially of oxygen, nitrogen, and very small proportions of carbonic acid gas and water vapor. The proportion of carbonic acid is 2 to 4 parts in 10,000. The amount of water vapor is greater in proximity to a body of water and varies with the temperature. Oxygen is the life-sustaining element of the air. Nitrogen dilutes it. Carbonic-acid gas, or carbon dioxide, is poisonous, and when present in the air in considerable quantity will cause dullness, headache, and fainting. Oxygen is consumed by the burning of candles, kerosene in lamps or stoves, gas, and by breathing. Exhalations are full of carbonic acid and other poisonous gases. As air is exhaled the gases diffuse, and the carbonic acid is soon distributed quite uniformly throughout the air of a room, thereby increasing the content to more than 4 parts in 10,000. When the proportion of carbonic acid gas goes up to 7 parts in 10,000 the effect of poor ventilation is felt, and when 10 parts is reached actual discomfort may occur. The carbonic acid content should therefore be kept below 6 or 7 parts in 10,000 by ventilation. As much as 1,800 to 2,000 cubic feet of fresh air is necessary for each occupant every hour to control the carbonic-acid content.

METHODS OF VENTILATING.

Mechanical means of ventilation are required for buildings of considerable size. Residences or small buildings may be provided with foul-air flues or with a ventilating chimney. One-story buildings in which there is one large main room may have a galvanized-iron or copper ventilator in the roof through which obnoxious gases will be drawn away.

For houses of certain types a ventilating chimney when used in connection with a hot-air furnace will give excellent results. In place of the ordinary brick flue a large shaft is erected through the center of the house. Through the middle of this stack is run the smoke pipe, which for low buildings may be of terra-cotta pipe tightly cemented at the joints. A wrought-iron stack is preferable. This stack rests on a cast-iron bed plate supported by a brick pier and should be properly anchored and stayed with iron braces in the brick-work every 8 or 10 feet. A heavy galvanized-iron hood supported by upright iron standards should be mounted on top of the stack. The smoke pipe should be built up and braced as the stack is erected, and frames for the foul-air registers should be set into the stack from the different floors at the same time. The heat from the smoke pipe or flue will expand the air in the ventilating shaft, causing an upward movement of the air that will exhaust the foul air from each room connected with it.

If a central ventilating shaft is not feasible other means should be devised to allow the escape of air from the various rooms, for fresh warm air can not enter unless it displaces an equal volume of room air. That is sometimes the cause of a room not heating.

A fireplace is a very good form of foul-air flue, and if the house has several fireplaces no other foul-air flues are necessary. If several rooms open into one in which there is a fireplace this is generally sufficient for all the rooms. All fireplaces should have dampers so as to assure positive regulation as a vent flue.

Cracks around the windows and doors often serve to allow air to escape, but not if they are on the windward side. Sometimes it is well to provide either a recirculating duct or foul-air flues in the inside partitions. The foul-air registers are then placed at the baseboard, for the hot air enters the room opposite the windows, rises to the ceiling, and passes along it to the windows, where it is cooled, drops to the floor, and passes along it to the foul-air register. The hot-air register should be so located with respect to the foul-air return register that there will be no danger of the hot air passing directly to the return-air flue.

A return flue should not be placed in the bathroom, kitchen, or bedrooms on account of the danger of recirculating undesirable air from the first two; it might possibly be the means of scattering disease germs over the house. It is well to install in the bathroom and kitchen, vents to the outside air which can be opened or closed. A cheap foul-air flue can be made by placing a register in the baseboard opening into the space between the studding that is open to the attic; then the air may be discharged from the attic through a ventilator placed on the roof. Such a ventilating flue placed in the kitchen

should be located near the ceiling so as to carry off the fumes and odors from the cook stove. To secure positive action, the vent flue from the kitchen and bath should be built within the chimney, so that the heat from the smoke pipe will assure it a draft. Care should be taken not to connect two rooms to the same studding space. Where the slight additional cost need not be considered it is better to connect each flue separately with the ventilator.

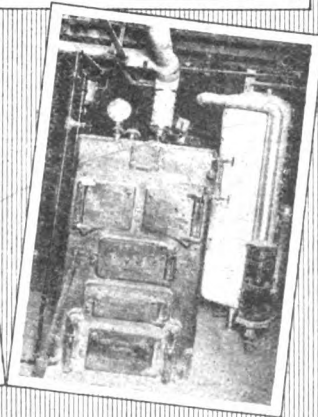
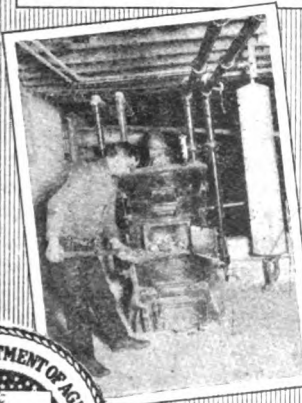
Where residences are heated by means of warm-air furnaces considerable saving in fuel is possible by means of a recirculating duct. Separate ducts from each room except those likely to contain obnoxious gases may be installed so as to empty into a larger one which discharges into the cold-air shoe at the base of the furnace or into the cold-air duct between the outside opening and the cold-air pit. A more common method is to build one large recirculating register in the lower hallway, either in the floor or wall, through which all the air within the house may be led back to the furnace. The saving in fuel consumed is directly proportional to the comparative volume and temperature of this air to the total quantity delivered into the rooms for heating purposes. All recirculating ducts should have dampers where they enter the unheated air-supply chamber.

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1194



OPERATING A HOME HEATING PLANT



MODERN heating equipment is now used in many farm homes. A large proportion of these installations are burning more fuel than they should or are not heating the house satisfactorily. This may be due to the selection of a plant of the wrong design, size, or type, faulty installation, poor operation, or to loose-fitting doors and windows. In this bulletin the requirements that should be met in order to heat the home satisfactorily are discussed and advice is given concerning the selection, installation, and operation of home heating plants.

Washington, D. C.

Issued March, 1921
Revised September, 1928

OPERATING A HOME HEATING PLANT

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REQUIREMENTS FOR SATISFACTORY HEATING

THE satisfactory and efficient heating of homes requires, first, that the chimney flue be of the proper size and in the proper place; second, that a proper heating equipment be installed correctly; third, that the plant be understood thoroughly and operated in a manner to give the maximum return from the fuel consumed; fourth, that the house construction be so tight that heat is confined within and cold air kept out; fifth, that the air be kept humidified as near to the correct degree as possible; and, sixth, that fresh air be admitted either continuously or from time to time in sufficient quantity to obtain satisfactory ventilation.

Atmospheric conditions in our homes are seldom maintained as they should be. Houses are often overheated. In most cases practically no thought is given to humidity or to air moistening. Physicians insist that an overheated house is unhealthy, and that colds, sore throats, and coughs frequently may be attributed to continually breathing air having too low a moisture content.

To overheat a house is a wasteful practice. It means the consumption of more fuel than is necessary. In certain sections of our country climatic conditions often change rapidly from extremes of heat to extremes of cold. Under such conditions one can not be too well versed in the characteristics of his heating system. While this bulletin applies particularly to homes heated by warm-air, hot-water, or steam plants, many of the suggestions apply equally well where stoves are used.¹

THE CHIMNEY FLUE²

Chimneys defective in construction or badly located cause many failures of heating systems. Air passes up the chimney flue with a

¹ Department of Agriculture Circular 405, The Domestic Oil Burner, contains information on the application of the oil burner to such heating plants.

² Farmers' Bulletin No. 1230, Chimneys and Fireplaces, will be of interest to those about to build and to those whose heating plants are unsatisfactory.

spiral movement; therefore a round, smooth flue is preferable because it offers less resistance to the upward passage of the gases. For structural reasons and because of the increased cost it is not nearly so common as the square or rectangular flue. The square is preferable to the rectangular. Many chimney flues are not lined. That is a mistake. The first cost of a lined flue is greater, but the benefit is not only better furnace operation but continual fuel savings; moreover, the danger of fire is lessened.

The most efficient chimney, as far as draft is concerned, is one built perfectly straight from the bottom up with a round or nearly round flue, lined with tile or having the interior surface made smooth by other means. There is no advantage in tapering the inside toward the top. The cross section and height are determining factors of efficient service. The transverse area must be sufficient to pass the volume of air required to burn the fuel properly, and the height must be great enough to produce sufficient draft and insure against interference by adjoining buildings or projections of the same building.

In a square or rectangular chimney the corners are dead. The effective area in square flues is 85 to 90 per cent, and in rectangular flues about 75 per cent.

The size of flue required for warm-air furnaces and heating boilers depends upon the size of heating unit and somewhat upon the kind of fuel burned. In planning new or remodeling old installations, it is best to determine the size of smoke outlet of the heater required and then provide a flue which is at least equal in area. The recommendations of the manufacturers of furnaces as to area and height of flue are generally reliable. No furnace or heater flue should be less than 8 inches, inside diameter, round lining; $8\frac{1}{2}$ by $8\frac{1}{2}$ inches, outside dimensions, rectangular lining; or 8 by 12 inches, inside dimensions, unlined.

SELECTION AND INSTALLATION OF HEATING EQUIPMENT

The selection of the system to be purchased should be made with the greatest care and only after a thorough investigation of its suitability to the house for which it is intended.

The term "efficiency" applied to the maintenance of inside temperatures or to economy of operation of house-heating equipment may be misleading. All heat energy made available by a heating apparatus is ultimately transmitted to the outer air. The walls of the building, the windows, doors, etc., interpose resistance between the heated space and the outer air. If these are good insulators of heat then the resistance is relatively high, and a higher temperature will be maintained in the room with the same flow or radiation of heat than if they were poor insulators, hence the efficiency of heating equipment can be but relative.

Consequently, the heating plant with highest efficiency for a particular house must be judged by service to the owner. It will be the plant that gives the best service at the least cost. As individual demands and requirements differ, so opinions of users as to results from different plants will differ. Adequate service is the first requisite. If several will give this, then the selection depends largely upon the comparative cost. If the cost does not affect the selection, then

reliability and convenience of operation should be the determining factors.

Do not rely upon the judgment, opinion, or experience of any one person unless that person is familiar with all equipments and unbiased. Talk with owners of different plants, learn the disadvantages of their installation, and find out whether all the rooms are heated satisfactorily. If they are not, try to find out whether the fault lies in the unsuitability of the apparatus to the particular house or to improper installation or poor operation. If the owner seems satisfied, before you decide on similar equipment, assure yourself before placing the contract either that the plan of your house is essentially the same or that the system can give satisfactory results with either type of construction.

THE HEATER

After deciding on the type of apparatus be sure that the heater is of sufficient size to heat the building easily in the coldest weather. Consider service above price and appearance. Make a selection based on reputation, economy of fuel, and attention required for operation. Examine the joints to see that proper provision has been made for contraction and expansion, see that the castings are well made, free from large blowholes, cracks, or other imperfections. Inquire whether the manufacturer is reputed a maker of good heaters.

INSTALLATION

The best and highest-priced heater improperly installed may give less satisfactory results than the poorest and cheapest properly installed. Therefore consider well the competency of the man who is to do the work. He should have had experience in putting in similar equipment, should be in touch with the manufacturer directly or through a representative; above all a man who takes pride in doing good work. Having made a wise selection, realize that it is the business of the contractor to put in a successful plant and to his interest. Therefore do not dictate to him unless you are prepared to assume responsibility for the result. If locations which he proposes do not agree with your wishes, make sure that your choice will not affect the results.

Heating contractors expect to guarantee that the apparatus will heat certain rooms to a definite temperature under specified outside conditions. The purchaser should ask for such a guaranty.

UNDERSTANDING THE HEATER AND OPERATING IT INTELLIGENTLY

To warm a house at low cost the characteristics of the heater must be understood and it must be operated intelligently. Some mechanical apparatus may be almost wholly automatic in its action, but a domestic heating apparatus is not in this class. Its action must be controlled and its functions to some extent directed. All persons can not be expected to understand the technical details of heating problems, but it is in the interest of every owner to become as familiar as possible with the operation of the heating plant upon which he depends during the winter months.

It is not enough to install a heater, fill the bins with coal, and then expect it to do the business. Nor can economy be practiced and proper temperatures be maintained if a servant that has no interest in the annual coal bill be given free rein.

Waste should be eliminated. The heat locked up in every pound of coal that goes into a heater should be extracted. The ash can should contain no combustible. If it is possible with a certain coal consumption to maintain a comfortable temperature, to burn more is extravagance and waste. The average house owner burns too much coal, principally because he does not know how to regulate his heater.

Heaters should be studied in relation to the work that they are to do. Every owner should know how to regulate his furnace so as to make it follow the changes in the outside temperature.

REGULATING DAMPERS

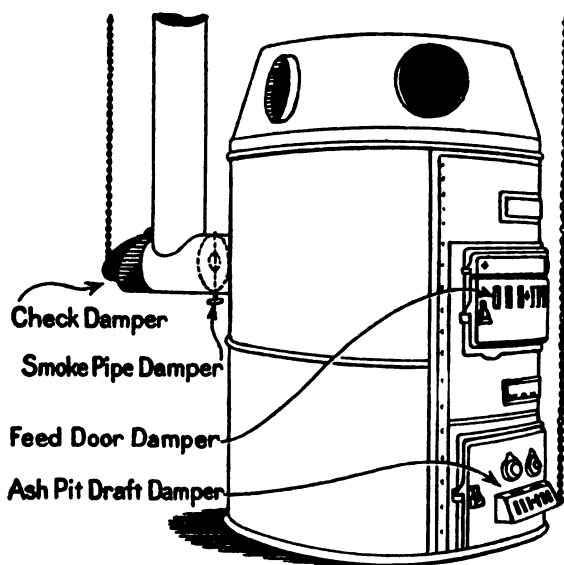


FIG. 1.—Location of furnace dampers

In Figure 1 the common location of dampers and checks is shown. While the illustration shows a warm-air furnace, the following explanation of the use of dampers applies equally well to any type. Four dampers should be provided. They are customarily referred to as the draft damper, the check damper, the feed-door damper, and the smoke-pipe damper. The draft

damper is generally a lift door or slide in the ash-pit door through which nearly all the air that makes the fire burn is admitted. The check damper is usually located at some point in the smoke pipe, not necessarily as shown in Figure 1. By opening this damper, cold air is admitted into the smoke pipe, interfering with the chimney draft, and retarding the burning of the fuel in the heater. This damper should be closed tight when fresh coal is added to the fire. It is convenient to have a chain connected to it and run through the floor above, so that it may be operated without making a trip below, though with this arrangement inspection of the condition of the fire is impossible and there is the chance that it will not receive the attention it should. The feed-door damper, consisting of a slide in the feed door, is of more importance than is usually supposed; through it cold air is admitted directly over the fire; if opened wide it acts as a check, similar to the check damper; if the opening is properly regulated it

admits just sufficient air to supplement that admitted through the draft damper, causing more perfect combustion of the fuel. The fourth damper, known as the smoke-pipe damper, is particularly valuable for a chimney with an exceptionally strong draft, as it gives more effective control than can be obtained with a check damper only, in windy weather or at night; this damper is frequently omitted, sometimes without detriment, but it is best that it be provided, and it should always be placed between the furnace and the check damper and never between the check damper and the chimney flue.

Another damper, known as the hot-blast damper, is provided for soft-coal furnaces. This draft opening connects with an independent air chamber for admitting heated air above the fire. Its function is essentially the same as that of the feed-door damper, differing from it only in extent.

OPERATING DAMPERS

When a fire is to be started, after preparing the firepot with light material and placing a little heavier wood on top, open the draft damper wide, close the check and the feed-door dampers, and set the smoke-pipe damper so that the wood fire burns briskly but not too fast. When the wood is burning thoroughly throw on coal, spreading it well over the burning mass of wood. Do not put on too much coal at one time. See that the fire continues to burn well. If blue flames are noticed sprouting up over the coal when the feed door is opened, then open the feed-door damper to admit additional air to burn the gases that are being given off from the coal. When the blue flames disappear close the feed-door damper and permit the fire to burn up until the temperature of the house has about reached that desired. Then close the draft damper and open the check damper until the fire seems to stand still. It may be found necessary to keep the draft damper slightly open. The owner should experiment with these two dampers to determine just how far each should be opened to hold the fire so that the desired temperature is maintained in the rooms.

When the fire is to be closed down for the night, after having thrown on fresh coal or banking cinders, close the check damper and open the draft damper, allowing them to remain so until gases cease to be given off, indicated by the disappearance of blue flames over the coals; then close the draft damper and open the check and the feed-door dampers. Sometimes it may be advisable to close the smoke-pipe damper completely. This must be determined for each installation, as it is dependent upon the chimney draft and the weather.

There is another factor that affects the damper operation. Different kinds or grades of coal require different quantities of air for combustion, and consequently a damper must be opened just wide enough to burn the coal most economically.

SELECTION OF FUEL

Let it not be assumed that one grade of coal will be as satisfactory as any other. The best fuel, that which will require the least attention in burning, will be the most economical and will give the greatest satisfaction. Sometimes poorer coal may have to be used, as was the

case in many domestic heating systems during the war, when transportation problems compelled the use of poorer grades.

Fuels for house-heating purposes may be mentioned in the order of their desirability as follows: (1) Anthracite coal in sizes commonly known as pea, buckwheat, chestnut, stove, egg, and furnace; (2) gas-retort or metallurgical coke in pieces one-half inch to 3 inches through; (3) coal briquettes, 2 to 3 inches in diameter; (4) screened Pocahontas (semibituminous) coal, over one-quarter inch and up to 3 or 4 inches in diameter; (5) sized bituminous coal in pieces one-half to 3 inches across. Although a good grade of hard coal is generally considered to be preferable to any other fuel for house-heating furnaces, coke may often be found to be more satisfactory than the grade of hard coal obtainable. The smallest size of coke, known as No. 2 nut, running from one-half inch to 2 inches, frequently may be purchased at a price below that asked for the usual furnace sizes, because of the popular impression that it can not be burned successfully on ordinary furnace grates. Investigations have shown this size of coke to be very satisfactory for heating houses and stores. A larger size does not lie so closely, and therefore frequently burns too fast, requiring more frequent firing. It is generally thought that this smaller coke is subject to heavy leakage through the grate bars into the ash pit. Excessive shaking would probably produce this result, but a coke fire requires less shaking of the grate than a coal fire. In ordinary weather one shaking a day, preferably in the morning, is all that will be necessary. In very cold weather the grate may have to be shaken before firing. Better results are obtained with little shaking, and the fire should never be shaken so much that pieces of hot coke fall into the ash pit. Therefore, as soon as sparks appear in the ash pit, stop shaking. Some who have burned coke for years claim better results from leaving a layer of ashes 1 to 2 inches thick on the grate all the time. The ashes check the draft and keep the hot coke from coming in contact with the grate. Although this size of coke clinkers rather freely, the clinker is soft and quickly breaks up. Clinkers should be removed while the fire is hot and before fresh fuel is put on, because under such conditions the ignited coke in the fire pot is in a semi-plastic state and when distributed by the removal of the clinkers merely settles down in the grate without falling through.

ATTENTION TO THE FIRE

Generally speaking, comparatively little attention is given the fires in house-heating equipment. In some cases the fire is permitted to vary from one extreme to the other. No attention is paid to it until the house becomes uncomfortably cold or too hot. It should receive attention at regular intervals. Usually the man of the house will attend to it early in the morning, late in the afternoon, and just before retiring with more or less regularity. This enables him to study his fire and fuel and perhaps to judge the relative merits of different fuels used, providing he realizes that only by actual trial in his particular furnace under conditions of customary usage can he learn which fuel is best suited for his requirements.

It is impossible to state how often a fire should receive attention without knowing the actual conditions. The type of heating system

has much to do with it. No definite rule can be laid down that will apply satisfactorily in all cases. Thus the attention given to the fire will govern materially the fuel to be used. It is well for every individual to devote the first heating season after installing a heating system to a study of fuels and their burning in his particular heater.

Buy at least two kinds of coal at one time and experiment with each separately and mixed in varying proportions. Note their burning qualities, whether they catch quickly, how much ash is left, and what the condition of the ash is, whether one size filters through the grate unburned, whether another forms clinkers that are difficult to remove or fuses and forms a crust that interferes with the draft. An intelligent owner will soon be able to tell the kind of fuel best suited to his conditions and can then buy accordingly.

A fire should not be shaken down more than three times a day. Generally twice will be found sufficient—in the morning and in the late afternoon. Unless the fire has been burning hard continuously, and fresh coal has been fed to it at frequent intervals, care should be taken not to shake too much. Do not shake live coals through the grate. In mild weather let an accumulation of ashes

remain on the grate. Never leave ashes under the grate in the ash pit, but clean out immediately after shaking. The volume of the ash pit is designed to permit enough air to pass into and through it to burn the fuel properly and at the same time keep the grate bars

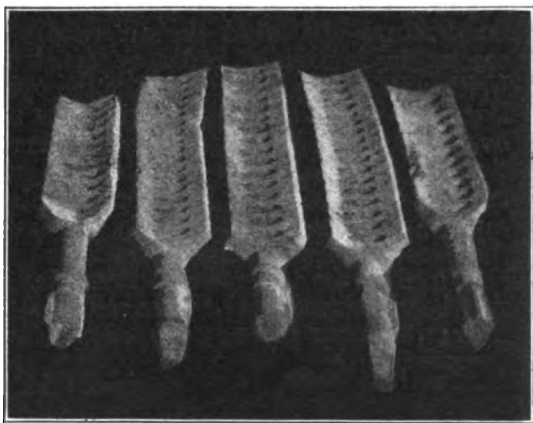
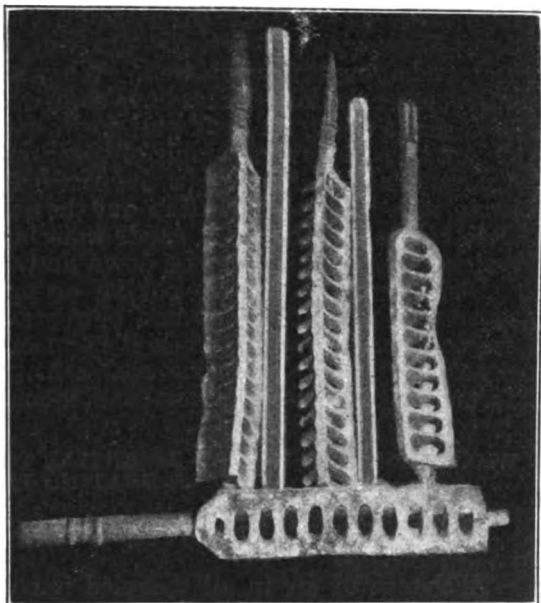


FIG. 2.—Grate bars warped and bent, due to allowing ashes to accumulate in the ash pit

cool enough to prevent injury from overheating. If ashes are allowed to remain in the ash pit they prevent necessary air circulation, hinder combustion, and cause damage to the grates. Figure 2 shows a set of grate bars removed from a furnace in which ashes had been allowed to accumulate.

Do not shake down a fire until it has had time to catch. When first attending the fire in the morning it is well to open the smoke-pipe draft damper and the ash-pit draft damper, throw on a little fresh coal, and allow it to catch well. When it is glowing, or, if one is in a hurry, after the blue flames have stopped flickering through the fresh coal, shake the grate back and forth with a short, quick movement. Do not turn the grates completely over unless it is necessary to remove a large clinker. As soon as the first bright spot is seen through the grate, stop shaking and clean out the ashes, sprinkling them if possible before handling. A small watering pot kept near the furnace assists materially in keeping down dust.

Disturbing the fire by poking or upturning is advised against wherever it will catch up and burn properly if given time. There are occasions, however, when it becomes absolutely necessary to use a poker. Caking or fusing coal demands attention to prevent the formation of a fused noncombustible mass directly over the grate.

WEATHER-TIGHT HOUSES ESSENTIAL TO ECONOMICAL OPERATION OF A HEATING PLANT

WINDOW AND DOOR LEAKAGE

A change of air in all occupied rooms is essential to health. In residences one complete change an hour is usually considered adequate, and calculations are so figured. Under conditions of moderate temperature, and wind the air change through window and door cracks, in houses of ordinary construction, is not objectionable. Neither does it materially affect the operation of the heating plant. But when a wind of 25 to 60 miles an hour often causes as many as five air changes per hour, the atmosphere in the rooms, especially on the windward side, may be several degrees below that usually maintained; then it is that the heating plant is often taxed beyond its capacity. Some rooms possibly are then closed off from the rest of the house, and an attempt is made to throw a maximum quantity of heat into one or two rooms. Remedies are numerous; the following may be mentioned: (1) Storm sash; (2) wood and felt weather stripping; (3) strip felting; (4) metal weather stripping; (5) calking compounds.

STORM SASH

Storm sash provide an air space between the two layers of glass. This air space has an insulating value which reduces the effect of the cold outside air both as regards chilling the heated air in contact with the glass and leakage around the inner sash. Popular and useful as they are, many persons nevertheless object to their unsightliness. If fixed, the value of the window for ventilation is lost; but the sash should be as air-tight as possible when completely closed. A home-

built one that permits opening at either the top or the bottom on a warm winter day is shown in Figure 3.

WOOD AND FELT WEATHER STRIPPING

Wood and felt weather stripping when put on properly aids materially in keeping out cold air. It should be applied on the outside at the opening between window sash and frame for the upper sash, and usually to better advantage on the inside for the lower sash. When applied to windows or doors the felt should be placed in such close contact that more than ordinary effort is required to move the window sash and that the door must be pushed hard in order to lock it. Wood and felt stripping may also be used between the frame and

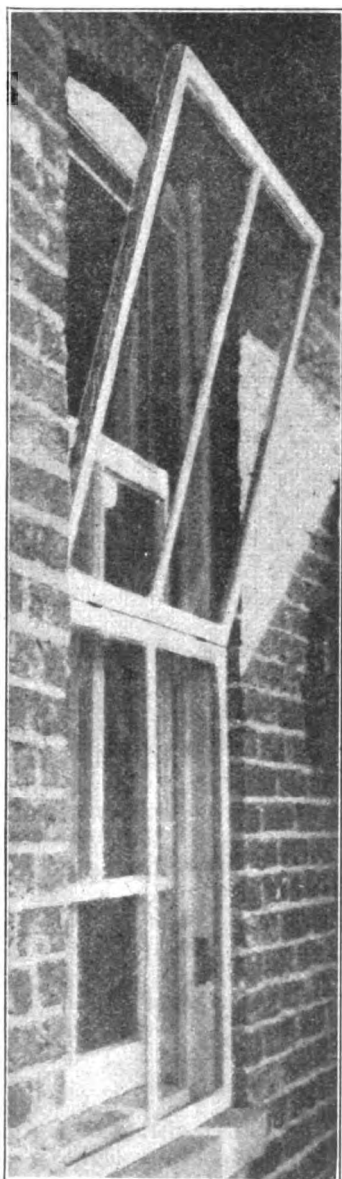
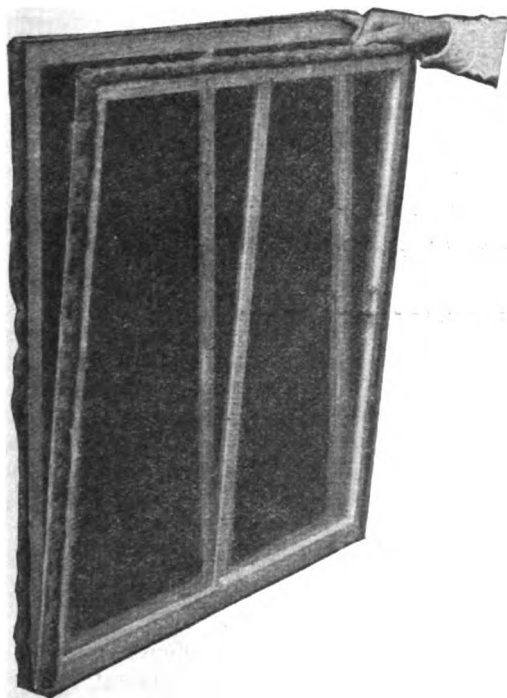


FIG. 3.—Home-built storm windows. By constructing the outer window in two parts and hinging them in the middle, rooms may be ventilated from above or below. Felt is tacked to the inner and side surfaces in order to make a tight joint, and the sections are held in place by screw hooks and eyes on each side.

wall where the wall line is not too irregular to completely close any crack there. Placed at the bottom of outside doors, wood and felt stripping aids materially in reducing drafts along the floor, a frequent

source of colds in young children. The stripping should be attached to the outside of doors opening inward. Drafts under interior doors may be stopped in a similar manner. When first applied this stripping is highly efficient, but may not long remain so. It tends to loosen from sliding sashes, while continual opening and closing of doors bends the felt back and forth, reducing the stiffness, so that it fails to close the crack completely. To secure the best results from its use on sliding surfaces, it should be reapplied every year, while that used on the bottoms of doors should be inspected and reset when it becomes less efficient. Many object to its unsightliness whether it be put on the inside or the outside.

STRIP FELTING

Strip felting may be used like the wood and felt stripping. If the wall line adjoining the window or door frame is irregular, the crack may be closed satisfactorily with strip felt. It may be forced in until it is flush. This affords a more sightly appearance than where wood and felt stripping is used. As a temporary expedient during short periods of high winds and low temperatures, strip felting may be used on the inside of all windows to close cracks by tacking it around the frame so that it rests against the sash. Thumb tacks mar less than carpet tacks and are more easily removed. Strips of this felt on the sill where the lower sash rests, at the top where the upper sash closes, and along the meeting rail aid materially. It can also be used to close cracks under doors. Note the door shown in Figure 4. At A strip felting was tacked to the frame and then wedged between the brickwork and door framing. Ordinary wood and felt weather stripping was nailed to the frame, so that when the door is closed no crack is left. To close the crack at the bottom, two sides of a strip of wood about 1 inch square were covered with felt and the strip was placed as shown at C, Figure 4, and held by a small angle iron and screws on each side. In the above manner all cracks around this door were so effectively closed that no water leaked into the cellar when it stood 12 inches deep in the areaway outside during a heavy downpour. This method of closing the crack under the door may be condemned by some on the score that it forms a stumbling block. While strip felting may be used to advantage and in some instances in a more or less permanent fashion, yet it must in general be considered a temporary expedient. Its unsightly appearance and the tack holes that are left are disadvantages.

METAL WEATHER STRIPPING

Metal weather stripping has shown itself a very efficient means of reducing crack leakage and thus a material aid in making a house weather tight. It is now obtainable in a variety of forms. To install it the window sash must be removed and grooves cut to receive the metal strips. When the work is properly done most of the stripping is hidden and the exposed part has a neat appearance. The work is usually done by an experienced workman, although handy men sometimes buy the stripping and install it themselves. Metal weather stripping should be permanent; it should allow easy move-

ment of sashes and at the same time effectually prevent the passage of air. Atmospheric conditions causing swelling or shrinkage of frames should have no appreciable effect upon its behavior. While beneficial results from it are recognized, the greater cost limits its use.

CALKING MATERIALS

Calking compounds are used to insure against air leakage between the window or door frames and the stone, brick, or concrete of the building. Temperature, moisture, and indeterminate causes make for expansion, contraction, and settling. A joint of cement, mortar, or other solid material is hardly practical. The space may be closed with oakum or other calking material forced into the opening. A good calking compound for this use should have the property of expanding as the crevice widens and contracting as the crevice narrows.

LEAKY FLOORS WASTE HEAT

Uninsulated floors permit waste of heat, and cold drafts sweep across them, making the room an unfit place for anyone to sit. Cellars are the best guarantee of warm floors, but, if conditions make it difficult or perhaps impossible to have a cellar, a coat of plaster between the rough and finished flooring will help to make a very tight and warm floor. Heavy insulating paper can be used with the same result, and sealing the joints with lath and plaster or wall board will do.

INSULATION FOR PIPES AND HOT-AIR DUCTS

The question of whether or not to cover the boiler and exposed piping in the basement depends very largely upon how much warmth in that part of the house

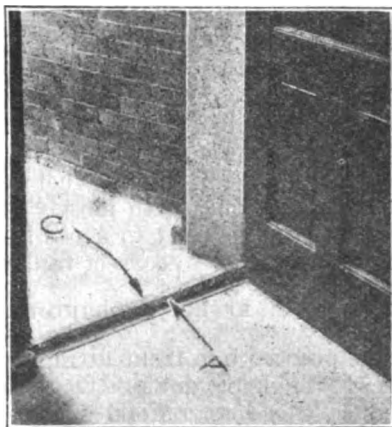
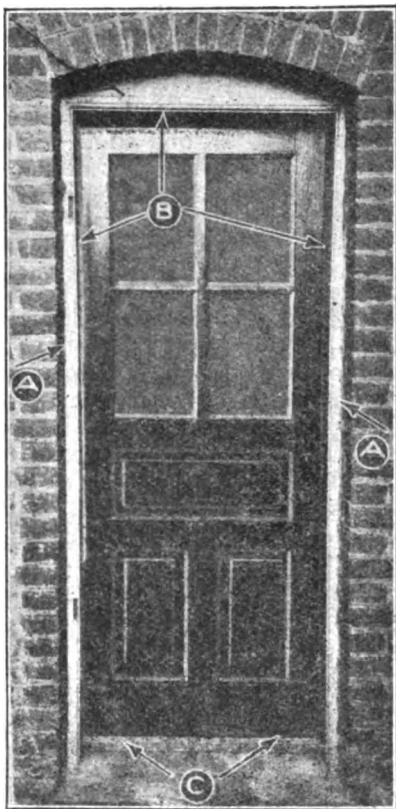


FIG. 4.—Strip felt and wood and felt weather stripping used to advantage in closing cracks. A represents felt tacked so as to cover the crack; B shows location of wood-felt nailed to the frame; and C is a block of wood covered on two sides with felt, placed so as to leave no crack under the door.

is desired. With a cellar that is fairly air-tight, not much saving in fuel can be effected by covering the exposed surfaces unless the resulting temperature exceeds that desired. Uncovered cellar piping often results in a more comfortable floor temperature of the rooms directly above. Insulating covering for hot-air ducts frequently proves advantageous. In one home where a hot-air duct was placed against the north wall, no heat could be obtained from the register until the space around the duct was packed with insulating material.

EFFECT OF CRACK OPENINGS IN WINDOW LEAKAGE

The clearance between window sashes and frames and between doors and frames varies from one-sixteenth to three thirty-seconds inch; in poor construction the opening may be as much as one-eighth to one-fourth inch. A clearance of three thirty-seconds inch is quite usual. With a wind velocity of 15 miles per hour this opening of three thirty-seconds inch would permit the passage of about $1\frac{1}{2}$ cubic feet of air every minute for every linear foot of crack around the window. An ordinary double-sash window (36 inches wide by 72 inches high) would admit about 30 cubic feet of air per minute. With one-sixteenth inch clearance 20 cubic feet per minute would be admitted.

The effect of this leakage upon the heating of the room may be serious. A room 10 feet wide by 20 feet long, with a ceiling 10 feet high, contains 2,000 cubic feet of air. Assuming that the longer side is exposed to the north or west, and that there are two windows with three thirty-seconds inch clearances, and assuming that the air is to be changed completely once each hour, which is customary for residential plants, it would require 2,900 heat units to raise the temperature from 0° to 70° F., with the wind blowing at 15 miles per hour. The air leakage through the clearances around the sash would be about 3,650 cubic feet per hour, or one and eight-tenths times the cubical measurement of the room. To heat this quantity of air about 5,300 heat units would be required, or approximately 80 per cent more than that required for one complete change of air per hour. If the wind velocity be 30 miles per hour, the leakage would be doubled and there would be required three and one-half times the number of heat units needed for one complete change per hour.

The advantage to be derived from good construction lies in the comfort had and in the fuel saved. More fuel is invariably consumed in a house with loosely fitted windows than in one where the clearance is reduced to a minimum. Increased fuel consumption is seldom adequate to correct faulty construction, particularly on windy days.

EFFECT OF USING METAL WEATHER STRIPPING

As pointed out, tight-fitting windows are essential if leakage losses are to be kept down. Ordinary felt weather stripping helps to reduce this loss. Metal weather stripping is still better and aids materially toward an annual saving of fuel. Some tests have demonstrated that it is possible, by the use of metal weather strip, to reduce

by 88 per cent the leakage through a one-thirty-second inch crack with a wind velocity of 15 miles per hour and by 83 per cent with a 30-mile wind.

The condition of the windows in a building, whether tight, loose, or loose enough to rattle, plays a very important part not only in the comfort derived from a heating plant but more noticeably in the annual cost of operation. Suitable metal weather stripping frequently reduces by 15 to 20 per cent the radiation required.

The prevention of window leakage means a saving of heat and a lessening of dirt blown into the house. In a certain apartment house, situated near a railroad station in a large city, during the first season of its occupancy the heating system supplied sufficient heat with a reasonable economy of fuel, but smoke and dust were a nuisance. Metal weather stripping was applied before the next heating season, and as a result the temperature of the rooms was too high. The radiating surface was reduced somewhat, and it still supplied sufficient heat, while the fuel consumption also showed a noticeable reduction. The dust nuisance was also reduced by the alteration.

RELATIVE HUMIDITY

It is now recognized that in addition to maintaining the proper temperature in an artificially heated house another factor of great importance is humidity, or the moisture that is present in the air. All air contains moisture in varying amounts, depending upon locality and temperature.

The moisture-carrying capacity of air depends on its temperature. Warm air has a much greater capacity for moisture than cold air, although it may feel drier. It is the relation between the actual amount of moisture in the air at a given temperature and the amount of moisture that the air could hold at that temperature that causes it to feel dry or moist.

Consider a piece of cloth held in a vertical position and sprinkled with water. No water will drip from the cloth until it is completely saturated, holding all the water that it is capable of holding. So it is with air. When the air is so laden with moisture that water is deposited in the form of dew the air has reached the point of complete saturation, known as the dew point. Then the relative humidity is 100 per cent. If air contains seven-tenths as much water as is present when it has just reached the dew point, its relative humidity is 70 per cent. If a room having a temperature of 40° F. with air at 70 per cent relative humidity be warmed up to 70°, the percentage of saturation decreases with the increase of temperature, since the warmer the air the more moisture it is capable of holding in suspension. Unless more moisture is added as the temperature is increased the percentage of saturation will be reduced, so that whereas the air at the lower temperature held seven-tenths as much as it was capable of holding, under the higher temperature it holds only two-tenths as much. Then its relative humidity would be 20 per cent.

There is little doubt but that in most dwellings during the heating season the air is drier than is best for health and comfort. The relative humidity is too low. A room in which the air is properly humidified will be more comfortable at a lower temperature than one in which the moisture content is too low.

Our bodies are cooled by evaporation from them. If the body be surrounded by very dry air evaporation will take place rapidly and produce a cooling effect so that a person feels cold. If the body be surrounded by moist air evaporation takes place more slowly, the rate of evaporation is less, and a person feels warm though the actual temperature of air may be lower. Too much moisture with heat is equally unpleasant, producing a muggy feeling, quite noticeable in some parts of the country where high humidity with high temperature prevails for long periods.

It is not believed that any investigations have proved definitely what are the best conditions as to temperature and moisture for our dwellings. Seventy degrees Fahrenheit is generally taken as the standard temperature for living and other rooms in which the occupants are inactive, excepting sleeping rooms. It is thought that for this temperature a humidity between 40 and 50 per cent should be maintained. It should not be less than 30 per cent, whereas it is probable that were the humidity in our houses tested it would be found usually to be 20 per cent or lower. That is as dry as desert air and predisposes persons that breathe it to throat and nose irritations. The drier the air the more difficult it is to heat a house with it. The moisture in the air carries and retains heat. In cold weather a considerable quantity of moisture is required if the humidity is to be kept up.

MOISTURE REQUIRED TO MAINTAIN HUMIDITY

Consider an average-sized house containing a family of five persons. Each person requires 1,800 cubic feet of air per hour; so 9,000 cubic feet ($5 \times 1,800$) must be provided for the occupants every hour. Cracks around windows and doors or the opening of doors and windows are usually depended upon to supply the needed air where a steam or hot-water heating system is installed. If a warm-air pipe furnace is used the fresh-air duct will take care of it. If air at 0° temperature and 70 per cent relative humidity is introduced into a house and heated to 70° F. and during the temperature rise no moisture is added the relative humidity will decrease to about 4 per cent. That is entirely too low.

Assume that the temperature is to be maintained at 70° F. and the relative humidity at 40 per cent, which is not too high. In order that those values be kept for 9,000 cubic feet per hour there would be required an evaporation every hour of roughly one-half gallon of water. Not many existing plants are capable of approximating that quantity.

HOW TO DETERMINE HUMIDITY IN A ROOM

A rough practical test for determining whether the air in a room is too dry is to observe the inside of windows on a cold day. If frost forms freely on the inside of the glass there is no doubt but that the inside air has sufficient humidity. If there is no sign of frost the air is likely too dry.

If a more accurate test is desired it may be performed with two thermometers in the following manner Use thermometers that have their bulbs completely exposed. Around the bulb of one tie a small

piece of cheesecloth or other porous fabric and thoroughly saturate it with water. Whirl this wet-bulb thermometer around on the end of a string 12 to 15 inches long. The height of the mercury in this thermometer will fall rapidly, owing to the evaporation of the water from the little sack surrounding the bulb. The drier the air the faster the mercury will fall. After two or three minutes, the wet-bulb temperature will become stationary. A reading should be taken instantly to obtain the low point. The dry-bulb thermometer reading should be taken simultaneously. Subtract the wet-bulb reading from the dry-bulb reading and refer to the accompanying table, from which a value for the relative humidity may be obtained.

The experiment can be performed with one thermometer by taking the average room temperature before using it as a wet-bulb thermometer.

TO USE THE TABLE

Suppose, with the dry-bulb temperature at 70° F., that the wet-bulb temperature became stationary at 56°. The difference between the two is 14°. Refer to the table and follow down the first column on the left to 70, then follow the horizontal line until the vertical column 14 is reached, and read the relative humidity, 40 per cent. For ordinary living rooms with temperatures of 68° or 70° the relative humidity should be between 30 and 50 per cent.

With the help of the table it should be an interesting experiment to determine the temperature to be maintained when the humidity is about what it should be; 40 per cent might be taken as a standard to work toward. Very probably the temperature in many houses has been maintained at 70° and above when it could be lowered were the relative humidity kept up to the proper value.

Reading of dry-bulb thermome- ter (de- grees F.)	Difference between dry and wet bulb (degrees F.)																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Relative humidity (per cent)																			
60.....	94	89	83	78	73	68	63	58	53	48	43	39	34	30	26	21	17	13	9	5
61.....	94	89	84	78	73	68	63	58	54	49	44	40	35	31	27	22	18	14	10	7
62.....	94	89	84	79	74	69	64	59	54	50	45	41	36	32	28	24	20	16	12	8
63.....	95	89	84	79	74	69	64	60	55	50	46	42	37	33	29	25	21	17	13	10
64.....	95	90	84	79	74	70	65	60	56	51	47	43	38	34	30	26	22	18	15	11
65.....	95	90	85	80	75	70	66	61	56	52	48	44	39	35	31	27	24	20	16	12
66.....	95	90	85	80	75	71	66	61	57	53	48	44	40	36	32	29	25	21	17	14
67.....	95	90	85	80	75	71	66	62	58	53	49	45	41	37	33	30	26	22	19	15
68.....	95	90	86	82	76	71	67	62	58	54	50	46	42	38	34	31	27	23	20	16
69.....	95	90	85	81	76	72	67	63	59	55	51	47	43	39	35	32	28	24	21	18
70.....	95	90	86	81	77	72	68	64	59	55	51	48	44	40	36	33	29	25	22	19
71.....	95	90	86	81	77	72	68	64	60	56	52	48	45	41	37	33	30	27	23	20
72.....	95	91	86	82	77	73	69	65	61	57	53	49	45	42	38	34	31	28	24	21
73.....	95	91	86	82	78	73	69	65	61	57	53	50	46	42	39	35	32	29	25	22
74.....	95	91	86	82	78	74	69	65	61	58	54	50	47	43	39	36	33	29	26	23
75.....	96	91	86	82	78	74	70	66	62	58	54	51	47	44	40	37	34	30	27	24
76.....	96	91	87	82	78	74	70	66	62	59	55	51	48	44	41	38	34	31	28	25
77.....	96	91	87	83	79	74	71	67	63	59	56	52	48	45	42	39	35	32	29	26
78.....	96	91	87	83	79	75	71	67	63	60	56	53	49	46	43	39	36	33	30	27

[Table based on 30 inches barometric pressure]

SUPPLYING MOISTURE TO THE AIR

There are several methods by which moisture may be added to the air supply of a warm-air furnace-heating system, although it is doubtful whether any at present are capable of supplying sufficient vapor to maintain high enough relative humidity to permit a room temperature much below 70° F. The common practice of placing a small cast-iron receptacle, called the water pan, in the side of the furnace casing is but a feeble effort in the right direction. It is seldom, if ever, large enough or has sufficient surface, while in many cases the pot is so placed that no appreciable amount of water can be added to the passing air. A small water pan set low down in the furnace has practically no effect. It should have a large area and be set well up into the warm-air space, so as to make evaporation as rapid as possible. The pan should be heavy enough to withstand rusting. It should be placed over the combustion chamber with its bottom at least 2 inches above the top. A supply pipe with ball stopcock and an overflow pipe make it easy to keep the pan filled with water. With a pressure water system automatic control is possible; the quantity of water evaporated increases with the quantity and temperature of the air passing through the furnace, so that the humidifying apparatus to some extent is self-regulating. A very effective pan may be made by riveting and soldering a strip of galvanized iron around the inside of the top casing directly under the openings for hot-air leader pipes. The ring should be from 2 to 2½ inches wide, with the inside edge turned up about three-quarters of an inch. A little cup riveted on the outside of the casing with small holes drilled through the casing permits hand filling, or a permanent supply pipe can be connected.

If there is a cold-air chamber a satisfactory humidifier may be provided by building a galvanized iron and wire rack with two or three sloping shelves to hold crushed coke. Insert a perforated pipe so that small streams of water will play upon the coke on the top shelf and trickle down through the ones below, thus keeping the coke continually wet. A drip pan at the bottom connected with an overflow pipe leading to a drain completes the apparatus. Another method is to spray the incoming air by means of several small atomizers arranged in the cold-air duct with a proper outlet for the overflow. Several commercial humidifiers for spraying the heated air as it leaves the furnace are also obtainable. Very satisfactory humidification has been secured with the better types.

So far as known no one has yet devised a satisfactory method of moistening air in houses heated by hot water. Pans which hang on the back of the radiator are obtainable, but do not have a large surface, and as they are not highly heated they are not very effective. Sheets of asbestos or blotting paper placed directly beneath the pans with one or more needle holes punched in the bottom adds to their effectiveness, as the paper absorbs the water and increases the evaporating surface. The objection to this arrangement is inability to control the flow of water. Wicks or an apron of absorbent material hanging down back of the radiator with one end resting in the water pan will draw up water by capillary attraction, and the air movement around the radiator will evaporate it and carry it off into the room.

Water pans are little more effective with steam than with hot-water radiators. Provision is sometimes made to discharge steam slowly into the room direct from the radiator. This proves much more effective where there is steam pressure, but many dislike the noise and odor of the escaping steam.

VENTILATION REQUIREMENTS

Air confined within an occupied room or building becomes foul and unfit for breathing. Fresh air is necessary to sustain life. Ventilation consists in the natural or mechanical displacement of vitiated air by fresh air. Complete renewal of air can not correctly be said to occur any given number of times in an hour, since a total change does not actually occur. What does happen is that the incoming air mixes with and dilutes the foul air to a point suitable for healthful respiration.

When air is taken into the lungs it has the temperature of the room, but when expired its temperature is 90° to 98° F. It is also nearly saturated with water vapor and is from 1 to 3 per cent lighter. These, however, are not the greatest changes. Air is composed essentially of oxygen, nitrogen, and very small proportions of carbonic-acid gas and water vapor. The proportion of carbonic acid is 2 to 4 parts in 10,000. The amount of water vapor is greater in proximity to a body of water and varies with the temperature. Oxygen is the life-sustaining element of the air. Nitrogen dilutes it.

Carbonic-acid gas or carbon dioxide in itself is not dangerous to health, but when carbon dioxide is exhaled, other gases that are harmful are given off at the same time and it is these that may prove a menace to health. The carbon dioxide serves more or less as an indicator of the presence of the real danger. If carbon dioxide is present in the air in considerable quantity, dullness and headaches are liable to result.

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September 20, 1928

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FARMERS' BULLETIN 1195
UNITED STATES DEPARTMENT OF AGRICULTURE

RICE AS FOOD



RICE MAY BE MADE
INTO APPETIZING
DISHES FOR ANY MEAL.
IT IS A GOOD BREAK
FAST FOOD AND AN
EXCELLENT BASIS FOR
SOUPS, SUBSTANTIAL
DISHES, SALADS, AND
DESSERTS.



RICE is one of the most important of the cereals, a group of foods that form a large part of the diet the world over. In this country wheat is the great cereal staple, for we are a bread-eating nation, and rice is not a bread grain. The texture and the mild flavor of rice, however, make it excellent for serving or combining with other food materials of pronounced flavor, such as meat, eggs, cheese, and some fruits and vegetables. Like the other cereals, rice is comparatively cheap, and using it to supplement and extend the flavor of more expensive foods may be found an economical practice in many American households.

Contribution from the States Relations Service

A. C. TRUE, Director

Washington, D. C.

May, 1921

RICE AS FOOD.

Prepared by the Office of Home Economics.

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RICE is more extensively grown and more widely used than any other foodstuff. This may surprise many Americans who do not realize that millions of people eat rice as regularly as Americans and Europeans eat bread. Rice is a palatable food when properly cooked, and it can be combined in many ways with more expensive and highly flavored foods into nutritious dishes. When potatoes are scarce and high in price, or when there is a shortage of wheat and other bread cereals, then rice is more extensively used; but under ordinary circumstances in many sections of this country it is neglected. In many households in certain sections of the South, however, it is used as often as potatoes are used in the North. In fact, in these regions a dinner would hardly be considered complete without rice served either as the starchy vegetable with meat or in one of the excellent combinations familiar in southern cookery.

Cereals of one kind or other are the staple of diet the world over because they are available almost everywhere, are comparatively cheap, and are nutritious and palatable. In Japan, parts of China and India, and other oriental countries rice is the mainstay because it is the most productive grain in the warm, humid parts of these countries, just as wheat is the most important food cereal in this country, Europe, and many other parts of the world. A shortage of the principal cereal used by a nation is more serious than a lack of any other food, as was shown by the wheat shortage in Europe during the World War and by the more recent so-called rice riots in Japan. Such shortage immediately affects those least able to bear it; the people with the lowest incomes are generally those most dependent on cereals.

In some parts of the Orient, where it is grown in large quantities, rice was and still is the medium of exchange. Debts, taxes, charities, various feudal obligations, pensions, even wages, were paid in rice. In China and Japan, for example, one of the earliest and most common institutions was the public-charity granary, where rice was received, sometimes as taxes, sometimes merely as gifts from the well-to-do or from the feudal lords, and stored as a community provision against times of famine. Rice plays an important part in the civil and religious rites and observances of many oriental countries. Moreover, necessity has taught the people in these densely populated rice-producing countries to use every part of their great

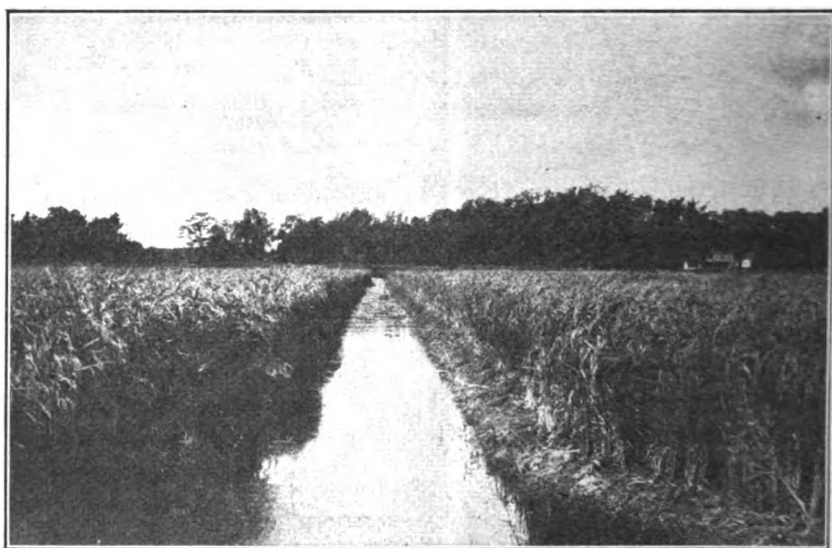


FIG. 1.—South Carolina rice field ready for harvest.

staple. Rice straw, for example, is used in China and Japan for making paper, matting, sandals, brooms, hats, and many other household and commercial articles.

Although the Orient produces about 97 per cent of the world's rice crop, the United States now grows more than enough to supply its own needs. Cultivation was begun in the Carolinas and Georgia in Colonial days and has now assumed commercial importance in Louisiana, Texas, Arkansas, and the Sacramento Valley in California, and there are scattering plantings in Mississippi, Florida, Alabama, and Missouri. The rice fields here are large, often several thousand acres in extent, and modern machinery much like that for seeding, harvesting, and thrashing wheat is used.

The varieties of rice grown in this country rank among the best of the world. Of the many tested here two varieties—Carolina Gold

and Carolina White—seem to be best adapted to the Atlantic coast fields; the Honduras and several Japanese varieties to Louisiana, Texas, and Arkansas; and the Japanese to California. The Honduras variety has long, narrow kernels, which, because of their length, are likely to be broken in milling. The Japanese varieties, which have short, round kernels, can be milled with less loss, an important point from the miller's standpoint. The Blue Rose variety is also a popular rice, with a kernel not so long as the Honduras and yet not so short as the Japanese varieties.

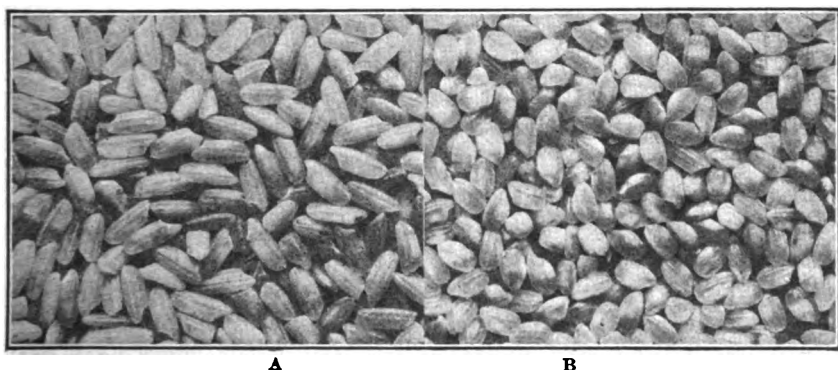


FIG. 2.—The two general types of rice now grown in the United States: A, Long grain; B, short grain. They are equal in food value and rank among the best rices of the world.

MILLING RICE FOR FOOD.

The grain, after it is thrashed, is known as rough rice, or paddy in oriental countries, and must be milled before it can be used as food. Rough rice consists of a tough, fibrous hull and a bran coat, inside of which are the germ and the main part of the grain, known as the endosperm in botany. Milling removes the hull, the bran layers, and the germ, leaving only the starchy endosperm. The primitive way of milling rice was to pound it by hand in a stone or wooden mortar with a pestle until the husk and cuticle cracked and rubbed off, and could be winnowed out, and this same principle is still used in oriental countries, though the power is usually applied in a more efficient way than by hand.

In this country more elaborate methods and more complicated machinery are used. The rough rice is first screened and fanned to remove particles of dirt, straw, and other foreign matter, and then passed between milling stones set just close enough together to break the hulls without crushing the grains. Fans blow out the light chaff, and a device known as the paddy machine separates out the grains that were not hulled the first time, so that they can be sent to other stones especially adjusted to hull the smaller grains.

At this stage the germ and outer skin still cling to the kernel. This is unpolished, or brown, rice and may be used as food without further milling. In order to give it a pearly luster, the rice is put through a series of machines that scour, polish, and in some cases coat it with glucose and talc. Bran and rice polish are the by-products of these milling processes which, although they rob rice of some of its most nutritious portions and much of its flavor, improve the keeping quality. Polished rice will keep almost indefinitely, while brown rice, because of the fat present in the germ and bran, is likely to become rancid, especially in warm weather.

The problem is very much the same as in milling other grains. For instance, the corn meal ground locally from the whole grain is richer and stronger flavored than the meal ground from kiln-dried corn from which the germ has been removed, but the latter keeps longer and is a better product for general marketing that involves long periods between milling and sale.

After milling, the rice passes through automatic machines which separate it according to size and weight and sack it ready for shipment.

In the process of milling about one-third of the weight of the rough rice becomes by-products, of which a little over half represents hulls and the remainder bran and polish. The hulls are worthless as food and are generally used as fuel in the mills or for packing material. They have also been used in the past by unscrupulous manufacturers as an adulterant of stock feeds. The bran is rich in fat, protein, and minerals, and when fresh and not adulterated with hulls makes excellent cattle feed and is regularly disposed of by millers for this purpose. It has been suggested that in times of food shortage rice polish might serve as human food, but as yet no very practicable methods of using it have been worked out.

FOOD VALUE NOT INDICATED BY COMMERCIAL CLASSES.

The classes of rice, or grades as they are sometimes incorrectly called, are based mainly on the percentage of unbroken grains or the size of the particles. These classes, then, have to do with appearance and commercial rather than food value, though there may be slight differences in chemical content. The housekeeper should remember in selecting a certain class of rice in preference to another that the price is no index to the amount of nourishment contained. In other words, it is often wise economy to buy the cheaper classes or kinds.

By means of carefully devised machines, milled rice is divided into three and sometimes four or five classes, consisting generally of head rice, second head, screenings, and brewers' rice.

Second-head rice consists in general of broken kernels approximately one-half and two-thirds the length of the perfect kernels, and sells for several cents a pound cheaper than head rice. When cooked it does not look so attractive as the unbroken kernels, but can be used to good advantage in combination dishes, soups, and the like, and offers a way of reducing one item in the family food bill without affecting the nutritive value.

Screenings is made up of pieces one-fourth and one-third the length of perfect kernels, and brewers' rice is broken in yet smaller pieces. Although screenings is likely to be pasty when cooked, it has practically the same food value as the more perfect kinds, and is equally good to use in soups and other dishes. Brewers' rice has commonly been considered too broken for table use, and as the name implies, has been disposed of chiefly to breweries. It is also an excellent feed for poultry and cattle.

FOOD VALUE OF RICE.

Rice is nutritious, easily digested, palatable, and a relatively cheap source of fuel for the body.

It is now generally agreed that the diet, as a whole, to be nutritious and palatable, must contain fuel in the form of protein, fat, starch, and sugar, mineral substances, fiber or so-called roughage, and finally the vitamins, recently discovered, but considered essential for health and development. There are now known to be at least three of these vitamins, which may, for the sake of brevity, be called A, B, and C. Whole milk and such of its products as contain butter fat and the leaf vegetables, such as spinach and lettuce, are believed to be rich sources of A; the portion near the germ of the cereal grains and all fruits and vegetables, of B; the juice of oranges, lemons, grapefruit, and of tomatoes, cabbage, and carrots, of C.

The rice grain before it is milled contains protein, fat, starch, sugar, mineral matter, fiber, and vitamin B, though they are not in the right proportion to meet the body needs. By removing the bran coat and the germ in milling, part of the protein, fat, and mineral matter and practically all the vitamins are lost, but the polished rice that remains is highly nutritious food, rich in starch and containing some protein and traces of fat and mineral matter. In fact, pound for pound, rice milled in the usual way contains about as much nourishment as highly milled wheat flour, the chief differences being that the wheat contains a little more protein and a trifle more fat and the rice more starch. Or, to put it even more broadly, the fuel value, commonly stated in calories, of rice, wheat flour, corn meal,

and in fact most of the cereals, is about the same; they each yield about 1,600 calories to the pound.

Rice is easily and thoroughly digested, and for this reason is often recommended as suitable for children and invalids. A series of experiments testing the digestibility of various kinds of raw starches carried on in this department has shown that rice starch is thoroughly assimilated even when raw, and that it is equal to wheat and corn-starch in this respect.

Much has been said in recent years about the relative food value of polished and unpolished rice, owing largely to nutrition experiments carried on in the Philippines, Japan, and other parts of the Orient. In the parts of these countries where rice is the most important cereal it has been found that a continuous and exclusive use of polished rice results in beriberi, one of the so-called deficiency diseases caused by lack of vitamine B. When the diet is varied and contains plenty of milk, fruits, and vegetables, as it generally does in this country, there is no lack of vitamine B, and consequently no objection to the use of polished rice, which contains nothing harmful in itself. Unpolished rice, however, many think, has a richer, better flavor, in addition to containing more of certain important nutrients: and if the demand should warrant, it could probably be successfully marketed like many other semiperishable products.

There has also been considerable discussion and misunderstanding as to just what is meant by the terms polished and coated rice and whether coating injures the food value. Polished rice has the bran, the germ, the gluten layer, and some of the outer layers of starch cells removed from it (p. 6) and may or may not be coated. The common practice in the rice mills in this country, however, is to coat polished rice with very small proportions of glucose and talc. The coating makes rice whiter and more lustrous, and, although it is a rather costly operation, millers and dealers believe that it pays. Since rice should be thoroughly washed through several waters before it is cooked, probably only very slight traces of coating remain. There is no evidence tending to show that coated rice, when properly washed and cooked, causes any digestive disturbances due to the small amount of coating left in the food. There is, therefore, no danger in using coated rice as a part of a mixed diet when the rice has been properly washed and cooked.

RICE AS A SUBSTITUTE FOR POTATOES.

When potatoes are scarce and high in price in the sections of the country where they are one of the staples of diet, rice is often served instead as the starchy vegetable accompanying meats, and makes an excellent and somewhat less expensive substitute. It is difficult

to determine just how much the saving is, because potatoes as purchased are about three-fourths water, and there is, of course, some waste in preparing them for cooking, while rice as purchased contains very little water, and is all edible. Moreover, during boiling, potatoes neither gain nor lose much in weight, but a fourth of a pound of dry rice absorbs enough water to become about a pound of cooked rice.

Rice and potatoes are not equivalent in food value, despite the fact that they both have a relatively large proportion of starch. Potatoes, unlike milled rice, contain in addition minerals and vitamins B and C. If the diet includes plenty of fruits and vegetables, however, the

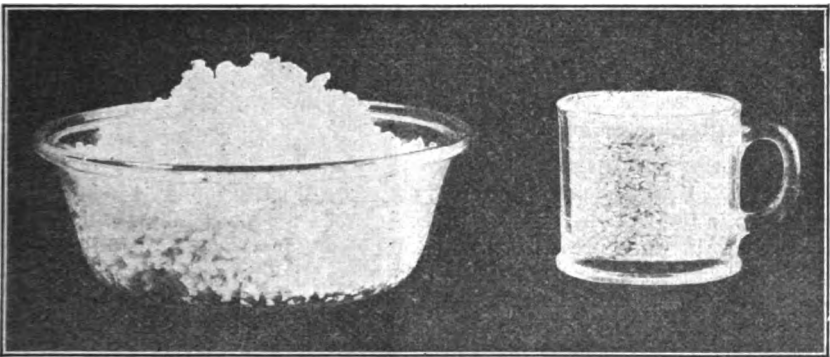


FIG. 3.—When cooked in 4 quarts of water a cup of rice more than triples in bulk and every grain remains separate.

use of rice instead of potatoes makes little difference from the standpoint of nutrition, because these needed substances are abundantly supplied by the other foods; but if the diet is so limited that potatoes are one of the few vegetables served, care must be taken to provide some other food that contains the substances lacking in milled rice.

HOW TO COOK RICE.

Methods of cooking rice vary considerably in different countries and even in different parts of the same country. In Japan, for instance, there are two common ways of boiling rice. In both cases the rice is washed until the water remains clear, and an iron or bronze kettle is generally used for cooking. For the first method, the washed rice is put into a relatively small amount of boiling water; for the second, it is put into cold water and gradually brought to a boil. When the steam and foam begin to escape from underneath the cover, the rice is considered cooked, but is allowed to stay in the covered kettle from one-half hour to an hour longer, while the steam makes

the grains swell and separate from each other. By the first method the cooked rice is drier and more flaky than by the second, though the difference is slight.

In this country, also, rice is boiled in several ways. No matter what method is used, it should first be thoroughly washed to remove all foreign substances and the loose starch, which if left is likely to make the rice grains stick together in a pasty mass when cooked. A good rule is to wash rice through several waters, or until the rinse water remains clear.

Southern cooks generally prefer to boil rice in a large quantity of water. Many use as much as 16 to 20 parts of water to 1 part of rice (4 or 5 quarts of water to 1 cup of rice).

BOILED RICE.

1 cup rice.

4 or 5 quarts boiling water.

1 teaspoon salt.

Wash the rice through several waters, until all the loose starch is removed and drain it. Have the boiling water ready in a deep saucepan, add the rice slowly drop in the rice, and allow it to boil rapidly for about 20 or 30 minutes or until a grain when pressed between the thumb and finger is entirely soft. In order to prevent it from sticking to the pan, lift it if necessary from time to time with a fork, but do not stir it, for stirring is likely to break the grains. When sufficiently cooked, turn the rice into a colander or sieve, and after the water has drained off cover with a cloth and set over a pan of hot water on back of the stove or in the oven; or turn the rice into a shallow pan, cover with a lid, and place it in a warm oven for a short time. Treated in this way the grains swell and are kept separate.

If a large kettle is not at hand, rice may also be cooked successfully in a smaller open saucepan or kettle, allowing eight times as much water as rice, or 2 quarts of water to 1 cup of rice. The same method is used as with the large proportion of water, but the rice requires more careful watching. If the starchy liquid surrounding the grains is washed off by pouring hot water through the colander in which the cooked rice is draining, each grain will be left separate and distinct. This is not usually necessary when the larger proportion of water is used.

The water drained from the rice after cooking should not be thrown away, as it contains much starch. It can be used for thickening in soups, stews, baked dishes, with or without milk, or, if boiled down, for starching fine sheer materials.

If boiled too long, rice becomes sticky and the grains tend to break apart. Many persons make the mistake of overcooking rice and also of not salting it enough, and because of this it has been unpopular as a vegetable in many households. It should be cooked only until a grain when pressed between the thumb and forefinger is soft and there is no hard, uncooked portion in the center. The rice should

then be immediately removed from the fire, drained, and dried in one of the ways described.

Some persons prefer to cook rice in a double boiler with an even smaller quantity of water. Three parts of boiling water are used to one part of rice, and a teaspoon of salt is allowed to each cup of rice. The rice is dropped into the hot salted water, the boiler is covered, and the rice is cooked for about 30 minutes. Then the lid may be removed and the rice cooked slowly a little longer until it has dried somewhat, or it may be turned into a pan, covered with a lid, and dried in a hot oven for a few minutes.

If rice is soaked in tepid water until the grains lose their luster and become solid white, the time of cooking by any method can be reduced approximately one-half. Rice

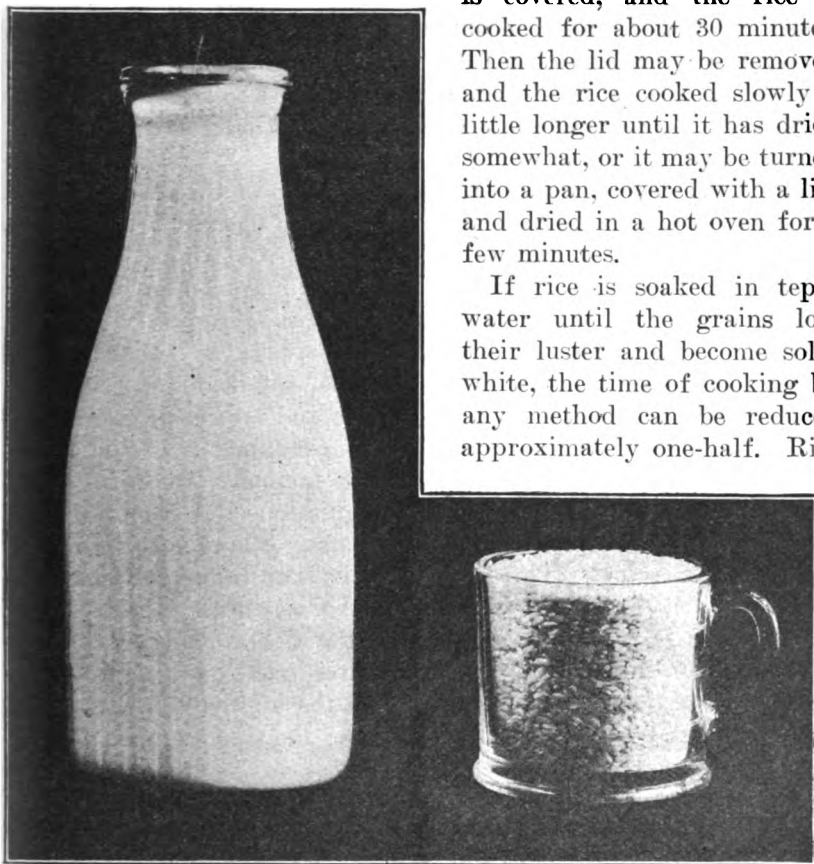


FIG. 4.—One cup of rice cooked in a double boiler will absorb a quart of milk. This makes a very nourishing food, especially suitable for children and invalids.

First washed and then soaked for 1 hour in tepid water will cook in 10 to 15 minutes in an open kettle and in about 20 minutes in a double boiler. The grains are very large and distinct if soaked and then cooked in a large quantity of water.

Rice, like all other cereals, may be cooked very satisfactorily in the fireless cooker. It should be prepared in the same way as for cooking in the double boiler, three parts of water being used to one part of rice. The rice should be dropped into the boiling water, boiled on the stove for 5 minutes, then put into the cooker for from 5 minutes to 1 hour.

Both the flavor and the food value of rice may be considerably improved by cooking it in whole or skim milk, or in half milk and half water, or by adding rich milk after it has been cooked. Rice will sometimes absorb as much as four times its volume of milk. This makes an especially nourishing food for children and invalids. Beef or chicken broth may also be absorbed by rice in the same way, making a very nourishing dish.

Because of its mild flavor and its texture, rice is especially suitable to combine with other foods of more pronounced flavor. For example, it can be used as the basis for substantial dishes to be served as meat substitutes or for nourishing soups and appetizing salads and desserts.

In countries where rice is an important item of the diet, it is commonly combined with some other local food of distinctive flavor. In Ceylon and India, for instance, the sauce for it is almost invariably flavored with curry, and the garnish dishes may consist of a dozen or more such foods as minced ham or salt fish, chopped boiled eggs, preserved ginger, horse-radish, pickled peppers, or other oriental fruits or vegetables; in Japan and China, soy-bean sauce or curd, which is not unlike some cheeses in taste and appearance, is served with rice; and in Italy it is frequently combined with the highly flavored cheeses for which that country is famous. American housewives have long used some of these combinations and from our great variety of food materials can work out many others with the aid of the following recipes. These recipes have been tested in the experimental kitchen of the Department of Agriculture. Highly milled rice was used in the preparation of all the dishes. Brown rice may be used in the same ways, but it requires from one-half to three-quarters of an hour longer cooking than the highly milled rice. As is the case with white rice, soaking reduces the time of cooking.

SOUPS.

Rice added to any kind of meat stock with a little parsley, bay leaf, or thyme, or a pinch of celery seed for seasoning makes a palatable as well as a nourishing soup. Also, rice makes excellent thickening for soups made of highly flavored vegetables, such as tomatoes, asparagus, celery, or onions.

CREAM OF CELERY OR ASPARAGUS WITH RICE.

$\frac{1}{2}$ pound celery or asparagus.	1 tablespoon chopped parsley or 1 tea-
$\frac{1}{2}$ cup rice.	spoon onion juice.
1 quart cold water.	2 teaspoons salt.
2 tablespoons butter, drippings, or	$\frac{1}{2}$ teaspoon pepper.
other fat.	1 quart milk.

Cut the celery or asparagus in half-inch pieces. Cook the rice and celery or asparagus in the water until both are tender. Press them through a colander

and add the fat, the seasoning, and the milk, and reheat. This will make 5 or 6 average servings.

RICE AND CHICKEN SOUP.

$\frac{1}{2}$ cup uncooked rice.	2 tablespoons chicken fat, butter, or other fat.
3 cups chicken broth.	$\frac{1}{2}$ teaspoon celery seed.
3 cups water or milk.	$\frac{1}{2}$ teaspoon salt.
$\frac{1}{2}$ cup minced chicken.	$\frac{1}{2}$ teaspoon pepper.

Cook the rice in the broth and the water or milk until tender. Add the minced chicken, the fat, and the seasoning. The minced chicken may be omitted if desired. This will make 5 or 6 average servings.

BAKED AND STEWED DISHES.

The baked and stewed rice dishes here given are planned with the idea of making appetizing and nourishing dishes in which small quantities of the higher-priced foods may be made to go farther than if served alone. Some of these combination dishes, such as Italian baked rice, savory rice omelette, and oysters scalloped with rice, can well be substituted for meat.

BAKED RICE AND GIBLETS.

1 cup cooked giblets.	1 teaspoon salt.
2 cups cooked rice.	$\frac{1}{2}$ teaspoon pepper.
2 cups gravy.	

Chop the giblets fine, mix them with the other ingredients, pour the mixture into a greased baking dish, and bake it for 20 minutes. A little finely chopped celery or green pepper may be added if desired. This dish will make 8 or 10 ordinary servings.

STEWED KIDNEYS AND RICE.

2 or 3 veal or lamb kidneys.	4 tablespoons butter or other fat.
1 teaspoon salt.	2 cups cooked rice.
$\frac{1}{2}$ teaspoon pepper.	1 cup water.
1 onion, chopped.	1 tablespoon flour.

Trim, split, and cook the kidneys for 10 minutes in boiling water. Cut them in small pieces, add the salt, the pepper, and the chopped onion, and sauté them in the fat until brown. Place the browned kidneys and onion in a baking dish with the cooked rice. Make a brown gravy by adding the flour and the water to the fat in which the onions and kidneys were browned and pour it over the rice and kidneys. Set the dish in a hot oven until the mixture is heated through. This will make about 8 or 10 average servings.

SAVORY RICE OMELETTE.

3 eggs.	3 tablespoons minced ham or left-over fried bacon.
$\frac{1}{2}$ cup cooked rice.	$\frac{1}{2}$ teaspoon salt.
$\frac{1}{2}$ cup milk.	$\frac{1}{2}$ teaspoon pepper.
1 tablespoon butter or other fat.	
1 teaspoon chopped parsley.	

Beat the whites and the yolks of the eggs separately. Mix all the ingredients, folding in the whites of eggs last. Pour the mixture into a hot, well-greased frying pan, and when it is brown, fold it over with a flexible-bladed knife. Turn the omelette out on a warm platter and serve immediately.

If desired, the meat may be omitted, and a little fresh sage, thyme, mint, celery, pimiento, or onion may be substituted for the parsley. This will make 5 or 6 average servings.

ITALIAN BAKED RICE.

4 cups cooked rice.	1½ cups tomato juice.
¾ cup grated cheese.	2 teaspoons salt.
½ cup chopped pimiento.	½ teaspoon pepper.

Mix the ingredients well together and pour into a baking dish. Cover the top of the dish with the pulp left from straining the tomatoes. Bake for 30 minutes in a moderate oven and serve hot. This dish will make 10 average servings

OYSTERS SCALLOPED WITH RICE.

3 cups cooked rice.	1 cup milk.
1 pint fresh oysters.	2 tablespoons flour.
1 cup chopped celery.	½ teaspoon salt.
2 tablespoons butter, drippings, or other fat.	½ teaspoon pepper.

Place alternate layers of rice, oysters, and celery in a baking dish and pour over them a smooth white sauce made by melting the fat and stirring in the milk, the flour, the salt, and the pepper. Bake for 20 minutes. This will make 8 or 10 average servings.

BAKED STEAK STUFFED WITH RICE.

1½ or 2 pounds round or flank steak.	2 tablespoons stock or gravy.
1 onion, chopped fine.	1 cup cooked rice.
1 tablespoon fat.	1 tablespoon parsley.
2 tablespoons Worcestershire sauce.	1 tablespoon flour.

Have the steak cut rather thin, pound it well, and spread on it stuffing made in the following way: Brown the finely chopped onion in the fat, stir in the flour, the Worcestershire sauce, and the stock, and cook this mixture until it is thick; then stir in the rice and the parsley, and add salt, if necessary. After the stuffing has been spread on the steak roll it and tie it, or fasten with skewers, and bake it slowly for 1½ hours. Slice it crosswise of the roll and serve it hot. This makes 8 or 10 average servings.

Most of the rice curries in the Orient are made with a basis of plain boiled rice, to which are added other dishes combining many foods and flavors. They are usually served in a curry dish with perhaps 8 or 10 small compartments. After taking a portion of plain rice, each person chooses as few or as many of the other dishes as desired, spreads them over the rice, then covers the whole mass with curry sauce made as follows:

CURRY SAUCE.

2 tablespoons fat.	3 cloves.
2 tablespoons curry powder.	1 tablespoon grated coconut.
2 cups hot milk or water, tomato juice, or coconut milk.	Salt and cayenne.
½ lemon.	1 chopped onion.
	1 tablespoon chutney.

Melt the fat and stir in the curry powder, add the milk or water, tomato juice, or coconut milk, and cook until it is smooth and thick, then add the other ingredients and let the sauce simmer for 30 minutes.

The dish known as pilau—a combination of rice, meat broth, meat, and fat—in some rice-producing countries forms the common staple food of the people. Pilau is also a popular dish in Turkey, where it is often colored with saffron and flavored with spices or mixed with currants in a way that does not find favor with western palates. Other forms and combinations are common in the Creole cookery of the Southern States. Any kind of meat or fowl may be used.

PLAIN PILAU.

1½ pounds meat.	½ teaspoon pepper.
3 cups water.	½ cup rice.
1 teaspoon salt.	4 tablespoons butter or other fat.

Place the meat in the cold water with the seasoning and bring it slowly to the boiling point, removing the scum that rises to the surface. Cook it just under the boiling point for 30 minutes, or until the meat is about half cooked. Pour the broth into a double boiler, add the rice, which has been washed thoroughly, and cook it until tender. The rice will absorb the broth and the grains will be unbroken. Add the fat just before removing the rice to serve. While the rice is being cooked finish cooking the meat by browning it in the oven or in an iron kettle on top of the stove. When both rice and meat are cooked pile the rice on a platter and place the meat on the rice.

BEEF WITH RICE AND VEGETABLES.

1½ or 2 pounds beef.	3 teaspoons salt.
½ cup flour.	½ teaspoon pepper.
6 slices of bacon.	1 small piece of bay leaf.
6 cups boiling water.	Lemon peel.
1 large onion.	½ cup uncooked rice.
6 cloves.	1 cup celery.
1 cup tomatoes.	1 cup diced carrots.

Use one of the less expensive cuts of beef. Pound the flour into the meat and cut it into inch cubes. Cut the bacon into fine pieces and fry it for a few minutes in a large deep pan. In the fat thus obtained brown the beef, turning it constantly; then add the boiling water, cook the mixture for a few minutes, and turn it into a large cooking pot. Add the onion, into which the cloves have been stuck, the tomatoes, the salt, the pepper, the bay leaf, and the lemon peel. Cover the kettle and simmer this mixture for an hour; then add the rice, the celery, and the carrots, simmer for 45 minutes, and serve hot on a platter. This will make from 12 to 14 average servings and is good when reheated.

SPANISH RICE.

3 onions (medium size).	3 cups fresh or canned tomatoes.
½ cup drippings.	3 green peppers cut into strips.
½ cup uncooked rice.	2 teaspoons salt.

Slice the onions and cook until tender and slightly brown in the melted fat. Remove them from the fat, add the rice, which has been carefully washed and dried, and brown it. Then add the cooked onions, the tomatoes, the green peppers, and the salt, turn the mixture into a baking dish, and bake it until the rice and the peppers are tender. This will make 6 or 8 average servings.

STUFFED PEPPERS.

8 green peppers (average size).
 1 cup chopped celery.
 3 cups boiled rice.
 2 cups canned tomatoes.

2 tablespoons butter or other fat.
 1 teaspoon salt.
 $\frac{1}{2}$ cup grated cheese.

Cut off the stem end of the green peppers and remove the seeds. Cover the peppers with cold water, bring the water to the boiling point, and cook them for 5 minutes. Cook the celery until tender. Mix the rice, the tomatoes, the celery, the fat, and the salt, and fill the pepper cases. Stand them close together in a baking dish, sprinkle the tops with the grated cheese, and pour a little water or tomato juice in the dish to keep them moist. Bake until the cheese is brown and the pepper cases thoroughly tender.

When peppers are not plentiful, two or three may be used to flavor the whole dish. In that case, slice the peppers, cook them until tender, combine them with the other ingredients except the cheese, pour the mixture into a baking dish, sprinkle the grated cheese on top, and bake until the cheese is brown.

BAKED ONIONS AND RICE.

6 or 8 onions.
 2 teaspoons butter or other fat.
 2 tablespoons flour.
 1 teaspoon salt.

Cayenne pepper.
 1 cup milk.
 $\frac{1}{2}$ cup grated cheese.
 2 cups cooked rice.

Pare the onions under water and parboil them until tender, changing the water once. Make a sauce by melting the fat, adding the flour, the salt, a pinch of pepper, and the milk. Cook this mixture until it is smooth, let it cool, add the grated cheese, and bring the sauce slowly to the boiling point, stirring it constantly. Place in a baking dish alternate layers of the rice and the onions torn apart, pour on the cheese sauce, and bake for 20 minutes. This will make 6 or 8 servings.

CAKES AND BREADS.

Cooked rice or rice flour may be used in various forms of breads, cakes, and cookies. Because of the lack of gluten, rice flour alone is not suitable for making bread, but bread of good texture may be made from mixed wheat and rice flour. During the war rice flour was found to be an excellent substitute for wheat in waffles and certain kinds of cookies and cake.

RICE WAFFLES.

1 cup cooked rice.
 1 cup wheat flour.
 1 teaspoon salt.
 1 $\frac{1}{2}$ teaspoons baking powder.

$\frac{1}{2}$ cup sweet milk.
 3 eggs.
 1 teaspoon butter, drippings, or other fat.

Press the rice through a coarse sieve. Sift the flour, the salt, and the baking powder together, then add the milk, the yolks of eggs, the rice, and the melted fat, and finally fold in the beaten whites of eggs. Have the waffle iron hot and well greased. This amount will fill the waffle iron four times.

This recipe may also be used for rice fritters by adding 1 tablespoon of sugar and frying in deep fat. If preferred, the grains of rice may be left whole.

RICE-FLOUR WAFFLES.

- | | |
|----------------------------|---------------------------|
| 1½ cups rice flour. | 1½ cups milk. |
| 1 teaspoon salt. | 3 tablespoons melted fat. |
| 3 teaspoons baking powder. | 2 eggs. |

Sift the dry ingredients together and add them slowly to the milk, beaten egg yolks, and melted fat. Fold in the stiffly beaten whites and cook the waffles in a hot, well-greased iron.

RICE SPOON BREAD.

- | | |
|----------------------------|-----------------------------------|
| ½ cup corn meal. | 2 cups sweet milk. |
| 1½ teaspoons salt. | 2 eggs. |
| 1 tablespoon sugar. | 1 cup cooked rice. |
| 2 teaspoons baking powder. | 1 tablespoon butter or other fat. |

Sift the meal, the salt, the sugar, and the baking powder together, then add the milk, the yolks of eggs (well beaten), the rice, and the melted fat. Fold in the well-beaten whites of eggs. Pour the mixture into a hot, well-greased baking dish and bake for 40 minutes. Serve the spoon bread hot. This will make 8 or 10 servings.

RICE AND CORN MUFFINS.

- | | |
|-----------------------------|--------------------|
| 2 cups corn meal. | 1 cup cooked rice. |
| 1 tablespoon sugar. | 2 cups sweet milk. |
| ½ teaspoon salt. | 1 egg. |
| 2½ teaspoons baking powder. | 1 tablespoon fat. |

Sift the meal, the sugar, the salt, and the baking powder together. Mix the rice, the milk, the well-beaten egg, and the melted fat; then add the meal and other dry ingredients. Bake the mixture in well-greased muffin pans. This will make 14 to 18 average muffins.

RICE-FLOUR COCONUT DROP COOKIES.

- | | |
|--------------------------|----------------------------|
| 2 eggs, well beaten. | ½ teaspoon salt. |
| ½ cup sugar. | 2 teaspoons baking powder. |
| 1 tablespoon melted fat. | 1 cup grated coconut. |
| 6 tablespoons milk. | 1 teaspoon vanilla. |
| 1½ cups rice flour. | |

Mix together the ingredients in the order given, drop the batter by the spoonful on a greased baking sheet, and bake for 15 minutes in a moderate oven.

SPONGE CAKE.

- | | |
|--|-----------------------------|
| 3 eggs (yolks and whites beaten separately). | 2 teaspoons lemon juice. |
| ½ cup sugar. | 1 teaspoon vanilla. |
| 1 tablespoon hot water. | ½ cup rice flour. |
| ½ teaspoon salt. | 1½ teaspoons baking powder. |

Combine the ingredients in the order in which they are listed and bake the cake as a loaf or in muffin pans.

This cake may be used as it is or as the basis for many desserts. Baked in a thin sheet, spread with soft jelly, and rolled, it makes a delicious jelly roll. It may also be served with a sauce like cottage pudding, or it may be baked in layers and put together with custard filling for a Martha Washington pie, or used for a shortcake with fresh fruit between the layers.

SALADS.

Cold boiled rice, if very dry and flaky, is an excellent basis for many salads and may be the means of using left-overs of vegetables, fruits, meat, or fish. For instance, left-over peas, carrots, green beans, or fresh tomatoes may be combined with left-over rice, and small amounts of fresh fruits may be used in the same way. Grapefruit makes a delicious salad served with rice and French dressing. Also plain, cold boiled rice or cold pressed rice may be served with lettuce with a hot or cold cheese dressing or with mayonnaise, either of which adds greatly to the nutritive value of the dish as well as gives it a distinctive flavor. The texture of rice is such that it readily takes up the flavor of any dressing.

CHEESE DRESSING.

2 teaspoons butter or other fat.	1½ cups milk.
2 tablespoons flour.	½ cup grated cheese.
1 teaspoon salt.	2 tablespoons lemon juice.
¼ teaspoon cayenne pepper.	

Melt the fat; add the flour, the salt, the pepper, and the milk. Cook the mixture slowly until it is smooth, then let it cool. Add the grated cheese, bring the mixture slowly to the boiling point, stirring it constantly, and add the lemon juice. Serve the dressing either hot or cold.

RICE COMBINATION SALAD.

1½ cups cooked rice.	4 tablespoons chopped celery.
4 tablespoons chopped pimiento.	4 tablespoons green peppers or olives.
3 tablespoons grated cheese.	Salt.

Combine the ingredients and serve on lettuce with French dressing, or mayonnaise, or cheese dressing. If the cheese dressing is used, omit the cheese in the salad.

RICE AND ONION SALAD.

1 cup cooked rice.	3 young onions, chopped fine.
1 teaspoon chopped parsley.	

Combine the ingredients and serve on lettuce with cheese sauce, French dressing, or mayonnaise.

RICE AND TOMATO SALAD.

Scald, peel, and chill small ripe tomatoes. Cut a cone-shaped piece from the stem end of each and with a silver fork carefully work in salt and pepper for seasoning; or remove the inside of the tomato and stuff the shell with chopped celery, green peppers, and nuts, mixed with salad dressing. Arrange the tomatoes on a bed of lettuce and cold rice and serve with boiled or mayonnaise dressing.

TUNA FISH OR SALMON SALAD WITH RICE.

Remove the bones and skin from a can of salmon or tuna fish and mince it finely. Add an equal quantity of cold boiled rice, and season the mixture with salt, pepper, and vinegar. Stir in enough boiled salad dressing to moisten it

and set it away for a while in a cool place. When ready to serve add a little crisp celery finely cut, and shape the salad in molds moistened with cold water. Turn them out on a bed of lettuce leaves and, if desired, garnish with stuffed olives cut lengthwise.

DESSERTS.

The use of rice in combination with sugar, milk, cream, and eggs as desserts is far more generally known in the United States than ways of combining it with meat or making it into meat-substitute dishes. Yet even the variety in dessert dishes may be considerably increased. All rice dishes made with considerable quantities of milk have high food value, and if not too sweet are particularly good for children and invalids. Rice molded and served with a sauce of fresh or cooked fruit, or hot boiled rice served with maple sirup or sugar, or ordinary sugar mixed with cinnamon, also makes a wholesome dessert.

OLD-FASHIONED CREAMY RICE PUDDING.

1 tablespoon uncooked rice.	½ teaspoon nutmeg or cinnamon.
1 quart milk.	1 teaspoon salt.
½ cup sugar.	

Wash the rice, add the other ingredients, pour the mixture into a good-sized baking dish, and cook in the oven slowly for about 2 or 3 hours, stirring it frequently. If allowed to cook slowly, the milk thickens to a creamy consistency and the rice swells to several times its original size. If double the quantity of rice is used, the mixture does not require such long cooking, as the rice in swelling thickens the liquid more rapidly, but the product is not so creamy. Often a half cup of raisins is added to the pudding and allowed to cook down with the milk.

RICE BAVARIAN CREAM.

½ cup uncooked rice.	Nutmeg or cinnamon.
½ cup sugar.	Whites of 2 eggs.
4 cups milk.	1 teaspoon salt.
1 tablespoon granulated gelatin dissolved in 4 tablespoons cold water.	½ teaspoon vanilla.

Wash the rice and cook it with the sugar, the salt, and the milk until soft and thick, stirring it frequently. Soak the gelatin in the cold water, stir it into the hot rice mixture, add the spice, and let the mixture cool. When nearly set, fold in the whites of eggs beaten stiff, stir in the vanilla, and turn the mixture into molds. Serve with whipped cream or with a custard sauce, dotted with tart jelly. This will make 8 or 10 servings.

CHOCOLATE RICE PUDDING.

2 cups milk.	½ teaspoon vanilla.
1½ squares chocolate.	1 tablespoon cornstarch.
½ teaspoon salt.	2 cups cooked rice.
½ cup sugar.	

Heat the milk, the chocolate, the salt, the sugar, and the vanilla together until the chocolate is melted and well blended with the other ingredients. Moisten

the cornstarch and stir it into the mixture, add the rice, pour the mixture into a baking dish, and bake it for 20 minutes. This will make 8 or 10 average servings.

RICE AND TART APPLE PUDDING.

6 medium-sized tart apples.
1 cup granulated sugar.
 $\frac{1}{2}$ lemon or orange rind.
Raisins.

2 cups boiled rice.
2 tablespoons butter or other fat.
 $\frac{1}{4}$ teaspoon cinnamon.
2 tablespoons sugar.

Pare and core the apples, place them in a saucepan, cover them with water, and add 1 cup of sugar and the lemon or orange rind. Cook the apples slowly until they are nearly tender, remove them from the sirup, and fill the centers with chopped raisins. Put the rice in a baking dish and place the stuffed apples on the top of the rice. Boil the sirup until it is reduced one-half, add the fat just before removing it from the stove, and pour the sirup over the apples and rice. Sprinkle the cinnamon and the remaining sugar over the top and bake the pudding for 20 minutes. Serve the pudding either hot or cold with sauce or cream. This serves six persons.

RICE AND FRUIT COMPOTES.

Rice and fruit compotes are usually made with molded rice. To mold rice it should be cooked about 10 minutes longer than for ordinary cooked rice. Pour it into molds, place weights over the top, and chill it. Serve it with fresh sugared fruit or cooked fruits, or, if desired, dried fruits, such as raisins, may be cooked with the rice and the molds served with soft custard.

GENERAL HINTS ON THE USES OF RICE LEFT-OVERS.

Water from cooked rice may be used in soups, for the liquid in scalloped dishes, or for starching sheer materials.

Cold rice, or rice reheated by steaming, may be used as a breakfast dish with sugar and cream, with stewed fruits, or with baked or coddled apples.

Rice reheated by steaming may be served on a platter surrounded with carrots and peas, or turned over in browned butter or other fat and served as a vegetable.

Rice may be combined with vegetables and served cold with cheese sauce or mayonnaise as a salad.

Rice may be used for thickening soups, or in scalloped dishes instead of bread crumbs, or combined with chopped meat and seasoned with onion, parsley, or celery seed and made into croquettes.

Rice mixed with a little chopped meat and green pepper or celery makes a good stuffing for tomatoes or baked fish, or to place between two steaks of fish for baking.

The tougher cuts of meat may be combined in stews with left-over rice.

Rice may be recooked in milk, and a little butter or other fat and sugar added. This makes a particularly nourishing dish for children or invalids.

Rice scalloped with white sauce in which chopped or grated cheese has been melted, makes a substantial and appetizing dish suitable for luncheon or supper.

WILD RICE.

In various parts of this continent, especially in the north-central United States and south-central Canada, the plant sometimes called wild rice, but also known as Indian rice and Canada rice, is common along the edges of ponds and streams. It is not a true rice but belongs to a different botanical group, as is indicated by its scientific name, *Zizania aquatica*.

In early times wild rice was one of the staple foods of certain tribes of American Indians, ranking next to Indian corn in importance. They gathered it by paddling among the reedlike plants and shaking the ripe grains into the canoe. The grains are longer and less rounded than those of true rice and the husk is somewhat dark in color. The Indian women parch the rice in kettles over an open fire, and the heat not only improves the flavor and keeping quality of the grain, but also makes the rough husk easier to remove. The parched grain is tossed from birch-bark baskets to winnow out the chaff, but small portions of the hulls cling to the grains, and give them and the food prepared from them a grayish color.

The Indians generally boil wild rice or make it into soups and stews with such foods as fish or game, though they occasionally grind it and make it into thin cakes. In some localities wild rice was also a common food among early settlers and traders, who learned from the Indians how to prepare it. It is much esteemed by sportsmen, and has been introduced by them into clubs and private families, and occasionally appears on restaurant menus. In such establishments it is most frequently used as a vegetable, especially with game, but it is also served as a breakfast cereal.

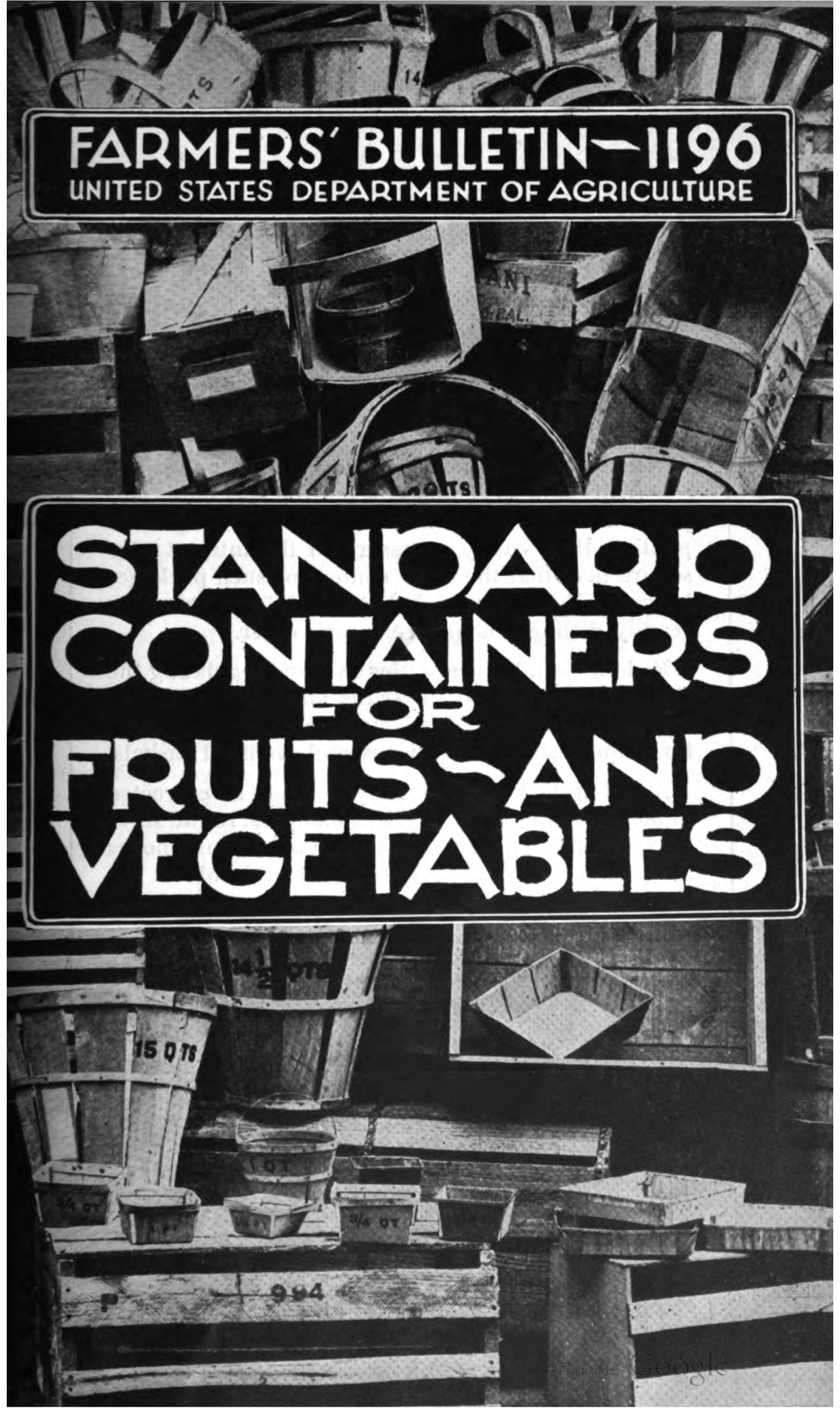
Samples of wild rice analyzed in the Office of Home Economics show that its general food value is much like that of other cereals, perhaps resembling wheat most closely. It contains rather more protein, fat, and ash than true rice, and proportionately less carbohydrates, but these differences are not pronounced. There is no reason to suppose that it is either more or less digestible than other cereals. A serious objection to growing it as a cultivated crop is that the grains shatter easily.

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FARMERS' BULLETIN—1196

UNITED STATES DEPARTMENT OF AGRICULTURE

STANDARD
CONTAINERS
FOR
FRUITS~AND
VEGETABLES

THE standardization of containers for marketing fruits and vegetables is one of the important problems which demands the attention of the general public. It is vitally necessary in the interest of a square deal that the exact content of such packages be generally known and that the different sizes be readily distinguishable from each other.

Federal standards are now in force regulating the sizes of barrels used for fruits and vegetables and for cranberries. Federal standards are also fixed for grape baskets, berry boxes, and small till baskets.

A serious lack of uniformity is still to be corrected in the sizes of such packages as hampers, round stave baskets, splint or market baskets, and of many boxes and crates used in the marketing of perishables.

Contribution from the Bureau of Markets

GEORGE LIVINGSTON, Chief

Washington, D. C.

April, 1921



STANDARD CONTAINERS FOR FRUITS AND VEGETABLES.

By F. P. DOWNING,¹

Formerly Investigator in Package Standardization.

IMPORTANCE OF STANDARD CONTAINERS.

STANDARD containers for marketing fruits and vegetables are of more interest to the average citizen than he generally realizes. Not only is he defrauded frequently by the substitution of short-measure packages at the full-measure price, which is inevitable if the difference in the size of packages is not easily detected, but also the cost of marketing is increased by the greater expense of manufacturing a large number of unnecessary styles and sizes and by breakage in transit, sometimes directly attributable to the difficulty of loading odd-sized containers. These losses constitute a wholly unnecessary tax on the fruit and vegetable industry.

SOME CAUSES OF VARIATIONS.

Probably the most important factor contributing to the present unsatisfactory situation is the use of regional packages long established by local usage. Such packages may have been satisfactory when their use was confined to a limited territory, but of late years rapid transportation and the use of special refrigerator and ventilator cars have brought the products of every corner of this country into our great marketing centers where the diversity of styles and sizes of containers have resulted in confusion.

There are in common use to-day about 40 sizes of cabbage crates, 20 styles of celery crates, 30 lettuce crates or boxes, 50 styles and sizes of hampers, 15 styles and sizes of round stave baskets, and

¹ The investigations which yielded the information presented in this bulletin were carried on by Mr. Downing. H. W. Samson, Specialist in Standardization, completed the preparation of the material for publication.

market baskets varying in sizes from 1 quart to 24 quarts, whereas relatively few standard sizes would satisfy all the demands of the trade.

The unfair competition of short-measure containers has been another unsatisfactory factor. Certain shrewd packers have found that by slight modifications in the shape of packages (See fig. 1) the cubical content can be reduced substantially without noticeably affecting the appearance. Commodities sold in these containers can be offered at a lower price per package than those sold in standard packages, but the price per unit of weight is of course higher. Often this has caused the general adoption of the short-measure package, and there is no end to this procedure, for once the short-measure is recognized as the standard a still shorter one is put out by the unscrupulous minority.

The 6-quart market basket, the 14-quart peach basket (fig. 1), the seven-eighths bushel bean hamper, and the 5-peck lettuce hamper are easily confused with peck, half-bushel, bushel, and $1\frac{1}{2}$ -bushel baskets. (See figs. 3 and 4.)

Another factor which has caused the addition of many unnecessary packages is the lack of a unit which is accepted as the basis for all package standards. If a manufacturer wishes to introduce a crate into a producing section normally using the barrel, instead of using the bushel unit, the tendency is to offer a barrel crate or half-barrel crate. At the present time the crates and boxes are being manufactured in sizes based on the United States standard barrel (105 quarts) with its subdivisions, the United States cranberry barrel ($86\frac{1}{2}$) with its subdivisions, the weight bushel, the heaped bushel, and the volume bushel. These different standards are used because of competing packages.

The result may be seen by a glance at the following table:

Three series of crates which can not be readily distinguished from each other.

Crates based on United States apple barrel.	Crates based on United States cranberry barrel.	Crates based on standard bushel.
1-barrel crate, 105 quarts.....	1-barrel crate, $86\frac{1}{2}$ quarts.....	3-bushel crate, 96 quarts.
$\frac{1}{2}$ -barrel crate, $52\frac{1}{2}$ quarts.....	$\frac{1}{2}$ -barrel crate, $43\frac{1}{4}$ quarts.....	$1\frac{1}{2}$ -bushel crate, 48 quarts.
$\frac{1}{4}$ -barrel crate, 35 quarts.....	$\frac{1}{4}$ -barrel crate, $26\frac{3}{4}$ quarts.....	1-bushel crate, 32 quarts.

It is highly improbable that anyone could tell the one-third cranberry barrel crate, containing approximately 29 quarts, from the standard bushel of 32 quarts, and even less likely that the one-half apple barrel crate, holding $52\frac{1}{2}$ quarts, could be distinguished from the $1\frac{1}{2}$ bushel crate, which contains 48 quarts. (See fig. 2.)



FIG. 1.—The apples on the floor represent the difference in the contents of the 14-quart and 16-quart baskets. By reducing the diameter of the bottom $\frac{1}{2}$ inch and making no change in the height of the baskets the deception is accomplished.

EXISTING FEDERAL STANDARDS.

The standard containers provided by the Federal Government for the marketing of fruits and vegetables are the standard barrel, con-

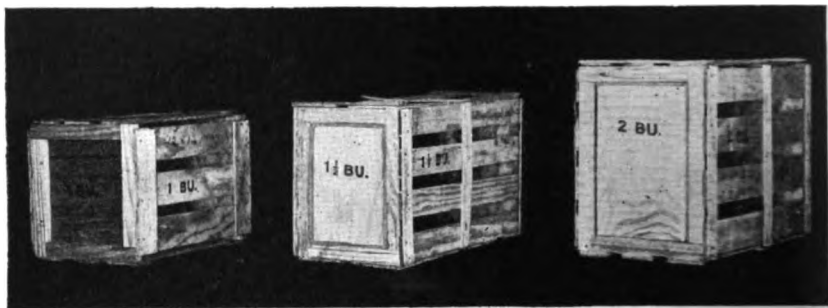


FIG. 2.—Suggested 1-bushel, 1½-bushel, and 2-bushel crates for general marketing. These sizes are easily distinguished, one from the other, by the eye.



FIG. 3.—The standard bushel hamper of 32 quarts holds nearly a peck more than the short basket. Thirty-three per cent of the hampers manufactured to-day are short bushels. The beans in front of the short basket represent the difference in quantity held by the two baskets.

taining 7,056 cubic inches, and its subdivisions; the cranberry barrel, containing 5,826 cubic inches, with its subdivisions; three standard sizes of Climax or grape baskets, containing 2, 4, and 12 dry quarts,

respectively; and standard berry boxes and till baskets, containing dry one-half pint, dry pint, dry quart, and multiples of the dry quart. The standard apple and vegetable barrel, which is ordinarily supposed to contain 3 bushels, actually holds 9 quarts in excess of that amount. In establishing this standard theoretical considerations were laid aside and the same dimensions and capacity were adopted as those of the flour barrel. The subdivisions of the barrel are three-fourths barrel, one-half barrel, and one-third barrel. The



FIG. 4.—Lettuce hampers vary in capacity from 40 quarts to 48 quarts, but frequently wholesale at the same price. The smaller basket in the picture holds 37 heads of lettuce, the larger 49 heads. The difference in contents is shown on the ground.

standard barrel Act is enforced by the Bureau of Standards, Department of Commerce, and in those States which have legally adopted the Federal standard, also by the local sealers of weights and measures.

The United States standard container Act, fixing standards for Climax baskets and for berry boxes and small till baskets, is enforced by the Bureau of Markets of the Department of Agriculture.

The two acts have done away with a large number of unnecessary sizes of barrels, berry boxes, and grape baskets, and have awakened a widespread demand for the application of the same principle to other containers. (See figs. 5 and 6.)

NEED FOR A FIXED UNIT AS BASIS FOR STANDARDS.

The dry quart with its subdivisions and multiples is a satisfactory basis for standardizing such small containers as the berry box and small till basket, but for larger packages a larger unit must be adopted, so that the purchaser of commodities in such containers can recognize readily the various sizes. For this purpose the Winchester bushel or struck bushel, containing 2,150.42 cubic inches, is believed the most satisfactory unit. The weakness of adopting arbitrary

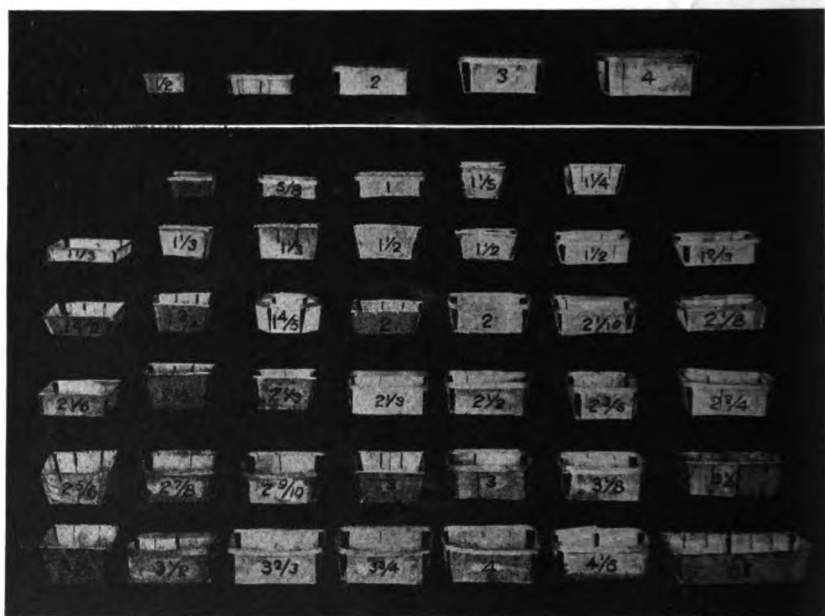


FIG. 5.—Above: Tills or small fruit baskets now standardized by law. Below: Some of the sizes of small fruit baskets in common use before Government standardization.

standards has already been shown as a cause of the present unsatisfactory situation.

A standard unit of measure should be permanent, definite, and of fixed and uniform value. The heaped bushel which is in common use is far from being fixed, and in many instances the heap has practically disappeared. A proper heap has never been defined by Congress, and in those States where an attempt has been made to describe the manner in which the measure should be heaped the phraseology generally is vague and indefinite. The heap has been referred to as a cone, the base being the top of the measure, and the height depending on the nature of the article when piled "as high as may be without special effort or design." Such vegetables as sweet potatoes under this definition might be piled so high that the heap would be as large as the measure itself.

Furthermore in certain States where determined efforts have been made to secure a proper heap to the measure, dealers have provided themselves with measures of small diameter. (See fig. 9.) Obviously the smaller the diameter of the measure the smaller the heap.

In case of shipping packages which must be provided with covers the heap necessarily must be eliminated. The State of New York has recognized these objections by repealing its laws requiring certain commodities to be sold by the heaped measure.



FIG. 6.—Above: Two, four, and twelve-quart Climax or grape baskets. Shipments of other sizes in interstate trade are prohibited by law. Below: Thirty-one types of Climax baskets in general use in 1917, before the establishment of standards.

Many States have attempted to define the bushel in terms of weight. However, if the bushel is at the same time to be regarded as a unit of volume this is impossible, as the weight of any given volume of fruits or vegetables will vary with the size, variety, condition of the product, and the tightness of the pack. Figure 8 shows a typical example. Here are two sweet-potato crates, one having a capacity of 1 Winchester bushel and the other an estimated capacity of 1 legal weight bushel. Both crates are sold as a bushel, but there is a difference of almost a peck in the actual content.

It is not clear just what was the basis for the weight-per-bushel laws which are now in effect, and wide differences may be found in

the laws of the various States. To illustrate, the legal weight per bushel of sweet potatoes is 46 pounds in the Dakotas and 60 pounds in Maryland, that of unshelled green peas is 28 pounds in Massachusetts and 56 pounds in Pennsylvania. A bushel of tomatoes is 45 pounds in Oklahoma and 60 pounds in Virginia. If the various States were to enforce rigidly these weight-per-bushel laws, interstate commerce certainly would be carried on under tremendous difficulties.

The struck bushel, which is the Winchester bushel of 2,150.42 cubic inches, is the most satisfactory unit for package standardization. It is recognized indirectly through a resolution of Congress, passed

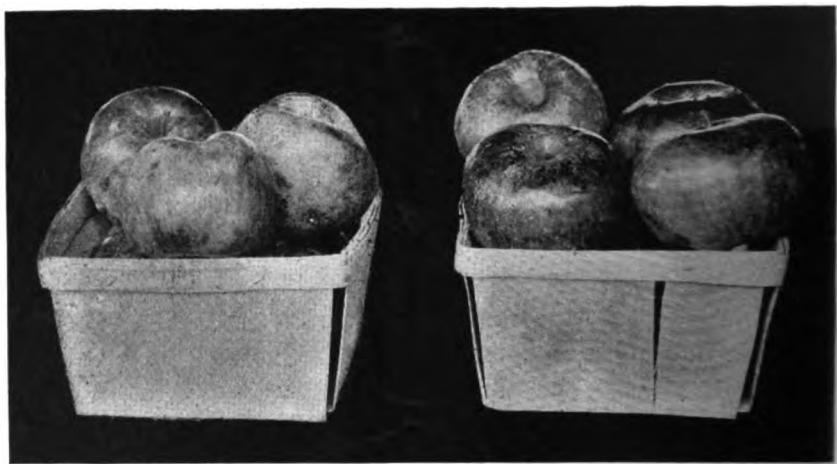


FIG. 7.—Misuse of a basket. Quart berry boxes are intended only for the marketing of berries, cherries, and similar fruits. There is a variation of 14 per cent in the weight of the apples in these baskets.

and approved in 1836, authorizing the Secretary of the Treasury to prepare a set of weights for use in the customhouses and for other purposes. The Treasury Department adopted the Winchester bushel and most of the States now recognize this standard by legislative enactment. A package based upon this fixed unit of volume, when filled level with the top, is recognized easily as a full measure. (See fig. 2.) Any variation or slackness in filling is detected at once even by the untrained eye.

SALES BY MEASURE VERSUS SALES BY WEIGHT.

In view of the difficulties which are necessarily encountered in attempting to secure a uniform method of filling or packing standard containers, it is generally recognized that weight is the only really definite basis of sale, and for that reason the pound or hundred-weight should be used where this is practical. An exception may be noted in regard to products which are carefully graded as to size,

in which case the sales may be made satisfactorily by numerical count.

To avoid such abuses as are frequently incident in repacking, the sale of commodities in quantities less than the original package should be by weight or numerical count. For example, 4-quart baskets of peaches are sometimes repacked so loosely that an extra basket is gained out of every 5 or 6 repacked; and 3 or 4 pounds of Malaga grapes are often removed from the California 4-basket grape crate before they are displayed for sale. Another evil attendant upon repacking is the use of small containers, which, although they conform to the standards, are not suitable for measuring certain products for which they are not intended. The 1-quart berry box and 2-quart and 3-quart till baskets are used extensively by retail dealers in the sale



FIG. 8.—These small potato crates vary 3 inches in length. Both are sold as bushels. The small 15-inch crate holds a volume bushel.

of apples, peaches, onions, and other large fruits or vegetables. Figure 7 shows how such dealers frequently resort to deceptive methods of packing, thus defrauding the unsuspecting customer who pays well for the empty spaces in the bottom of the basket.

However, for obvious reasons transactions involving the sale of original containers often can not be made on a net-weight basis without adding greatly to the cost of marketing. Perishable commodities must be handled with all possible dispatch, and the time and labor required to weigh each package would more than offset the good which might result from a knowledge of the exact weight. Furthermore, many sales are made while the products are in transit to market, and even if the weight at time of packing were known, a considerable variation from this weight might occur as a result of shrinkage due to drying out or decay. Then, too, a shipping package must be filled compactly without regard to weight or the product may be damaged by the movement within the container. In gen-

eral it may be said that transactions involving the sale of packed fruits or vegetables in the original container should be made by the standard package, but when it is necessary to break such packages in order to dispose of the commodity in smaller quantities, sales should be made by weight or count.

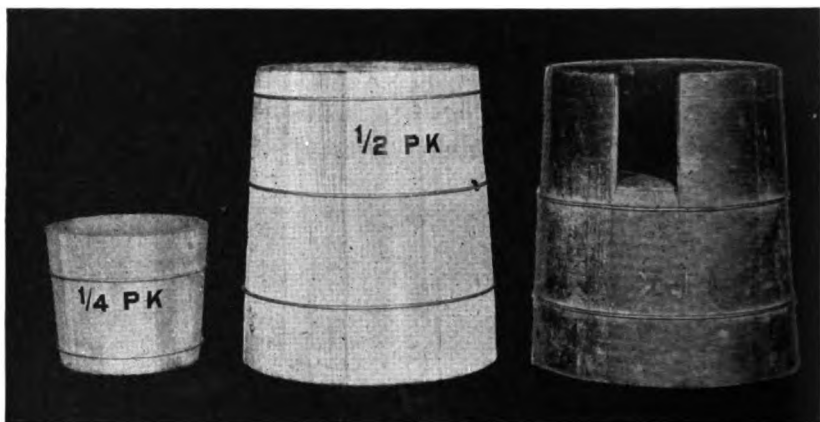


FIG. 9.—The double-ended measure, being narrower at the top than at the bottom, is easily “stacked.” Its use is forbidden by law in many States.

PROPER FILLING.

It is greatly to the advantage of all parties interested in marketing fruits and vegetables that, in addition to fixing standards for containers, proper methods of filling be employed. If containers are not

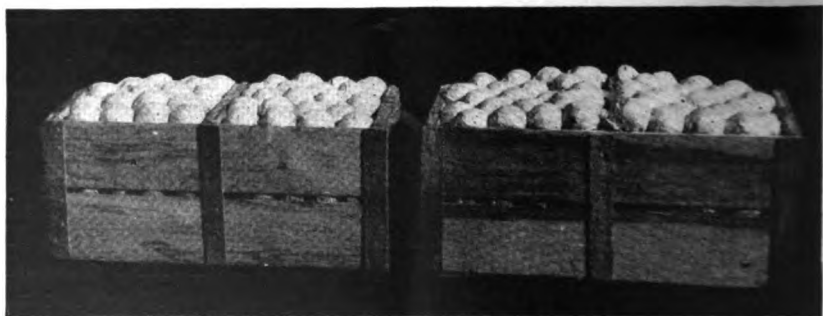


FIG. 10.—Florida orange box showing “bulge pack.” Left: The straight pack. Right: The pyramid pack.

well filled the waste space increases the package cost, and since freight charges are ordinarily based on an estimated per-package weight, the carriers receive pay for more than they actually carry when the containers are not full (See fig. 11); also the product is likely to be shaken and bruised in transit and discriminated against

by dealers in the markets on account of its poor appearance. The price penalty paid on account of poor filling is usually much greater than the actual weight shortage would warrant.

It is customary in packing fruits and vegetables to arrange the product to provide a bulge above the top of the container. (See fig. 10.) The cover is then put in place by pressure. When the height of the pack is not excessive this is a very desirable practice. As the natural shrinkage and settling occurs the product is held securely in



FIG. 11:—A "slack fill" of string beans in a short or $\frac{3}{4}$ bushel bean hamper. The beans at right weigh 23 pounds, at left 25 pounds. Average weight of properly filled hampers is 27 pounds.

place until the shrinkage is sufficient to offset the bulge. The extra amount of produce is more than paid for by the ready sale and better price which can always be secured for an attractive pack.

NEED OF FEDERAL STANDARDS FOR BASKETS.

There are three important shipping containers which are especially in need of standardization at the present time—the hamper, the round stave basket, and the market or splint basket. Investigations in all parts of the United States where these packages are used have shown a serious lack of uniformity in capacity, shape, and strength which could be corrected by the adoption of standards which have been prepared by the Bureau of Markets.

HAMPERS.

The hamper is one of the most widely used shipping containers, and is especially popular in the Eastern and Southern States. Almost 30,000,000 of these baskets are used annually. When made of light materials it is well adapted for marketing light produce, such as lettuce and kale, and when of heavier construction can be used in shipping such products as sweet potatoes and apples.

A glance at figure 12 shows a large number of styles and sizes in use at present. On account of the different shapes and sizes it is practically impossible for a purchaser to know just how much he is getting.

The need for standard dimensions perhaps is not generally recognized. On first consideration it would seem that if all standard bushel baskets contained the same cubic content there would be no chance for deception. This is not altogether true, as will be seen by referring to figure 13.

The baskets shown in this group are all standard bushels, but one would never know it by looking at them. Another important reason for fixing standard dimensions is to facilitate the development of standard rules for loading these containers in cars.

It is estimated that one-third of the so-called half-bushel hampers which are manufactured to-day are short measure. In fact, the use of the 14-quart basket has become universal in certain districts, having entirely supplanted the 16-quart or half-bushel basket.

The seven-eighths or 28-quart hamper is another size which should be eliminated. (See fig. 3.) It is used largely for shipping southern produce and masquerades as a full bushel in the markets. This basket has already been declared illegal in the States of Texas, New Jersey, and Ohio and in the District of Columbia. It is interesting to know that about 25 per cent of what are commonly supposed to be bushel baskets are short measure.

Still another size in common use which should be eliminated is the 5-peck hamper. This size does not meet any need which is not filled by the 1-bushel and $1\frac{1}{2}$ -bushel sizes.

The 20-quart or five-eighths bushel brace basket is used chiefly in the territory tributary to Philadelphia, where it is employed extensively in hauling tomatoes to the canneries. This size hamper is not to be regarded as a short container, as it is more likely to be confused with the 16-quart or half-bushel basket than with a larger size, but it does not appear in the list of proposed standards which are recommended by the Bureau of Markets.

The sizes of hampers which are recommended by the Bureau of Markets as being sufficient in number to satisfy all legitimate re-

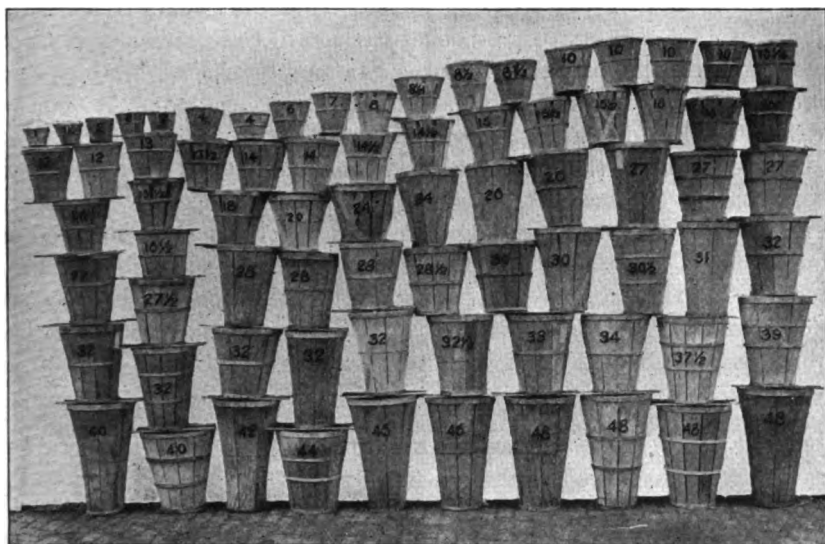


FIG. 12.—Above: Proposed standard hampers. All other styles should be eliminated. The $1\frac{1}{2}$ bushel hamper is made in two styles. Below: Group of hampers showing sizes and styles in general use to-day. A striking illustration of the need of standardization.



FIG. 13.—Showing need of standard dimensions for bushel hampers. The height of the six standard bushels varies from 17 inches to $22\frac{1}{2}$ inches, making a carlot loading of mixed hampers difficult.

quirements of the trade are as follows: Eight-quart, or 1 peck; 16-quart, or $\frac{1}{2}$ bushel; 32-quart, or 1 bushel; and 48-quart, or $1\frac{1}{2}$ bushel. (See fig. 12.) All of these sizes are necessary. It will be observed that there are two styles of 48-quart hampers shown in the illustration. These two styles are not necessary, but it seems expedient to use both, since the tall, narrow one is demanded in Florida for shipments of lettuce, but is not popular in other parts of the country, where a hamper of greater diameter is preferred.

ROUND STAVE BASKETS.

The round stave basket is popular in all regions except the Southern and Middle Atlantic States and on the Pacific coast. It is used for shipping a large variety of fruits and vegetables and is also used in the field in place of lug boxes. In recent years it has supplanted to some extent the 6-basket carrier in the peach districts of Georgia and the Middle Atlantic States because of the greater amount of labor necessary for packing the carrier. Some 18,000,000 or 20,000,000 round stave baskets are manufactured annually.

Figure 15 shows that in the case of the round stave basket, as well as in that of the hamper, a large number of unnecessary sizes are being manufactured at present. The sizes which are recommended as standards by the Bureau of Markets are the same as those recommended for the hamper except for the elimination of the 8-quart and the addition of the 2-bushel size. These four sizes shown in the upper part of figure 15 can be distinguished readily from each other by the eye.

SPLINT BASKETS.

Splint or veneer baskets are better known to the public as market baskets. They are manufactured from either broad or narrow splints, and there is a wide diversity in the dimensions of the forms used by the different manufacturers. The broad-splint type is sometimes known as the solid veneer basket.

Splint baskets may be divided into three classes—overhandle, drop-handle, and square-cornered. The overhandle has a single handle nailed to the center of each side; the drop-handle type has two handles that fold back over each end of the basket when not in use; and the square-cornered type, as the name indicates, has square instead of round corners. It is the best type of the three for shipping, as it is the strongest, and also loads in freight or express cars to better advantage. Square-cornered baskets are used extensively in the marketing of hothouse products, such as lettuce, tomatoes, and cucumbers.

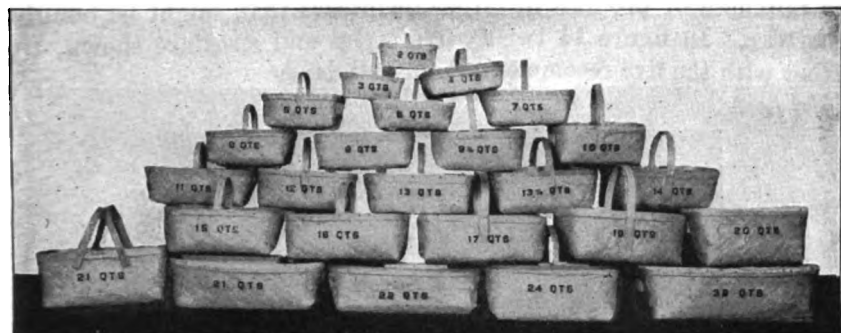


FIG. 14.—Above: Proposed sizes for standards. Below: Twenty-five styles and sizes of market or splint baskets manufactured and used to-day.



FIG. 15.—Above: Proposed standard sizes of round stave baskets. Below: Twenty sizes of round stave baskets in general use to-day.

The splint basket is used extensively as a shipping container for farm produce. In the farmers' market of one large city alone sales of produce in market baskets run as high as \$11,000 in a single day, and in many other cities the market basket is one of the most common containers. It is preeminently a direct marketing package, and it is valuable because it can be carried conveniently, thus encouraging the purchase of produce in larger quantities than might be bought otherwise. In figure 14 twenty-five styles and sizes are shown, together with the five recommended for standards.



FIG. 16.—The folding crate used extensively in marketing onions.

Many of the styles now in use are unnecessary and deceptive. The peck size has dwindled to one-fifth or one-sixth of a bushel, and the one-half bushel to 12 to 14 quarts, the standard sizes seldom appearing on the markets. The sizes which are proposed by the Bureau of Markets are five in number—4-quart, 8-quart, 12-quart, 16-quart, and 24-quart. Of these sizes the 12-quart and 16-quart will be used most generally. For heavy products the 12-quart size carries better than the 16-quart. The 24-quart size is used for such products as lettuce and spinach.

The number of splint baskets used annually is not known, but more of this type are manufactured than any other. Approximately 50 per cent of these baskets are manufactured in sizes varying from 13 to 15 quarts.

NEED OF STANDARD BOXES AND CRATES.

Fruits and vegetables are shipped extensively in boxes and crates. In many instances these containers have become so well established through long usage that they have practically become standards, and in a few cases these packages have been standardized by law. The latter situation is true of the northwestern apple box (Fig. 17), the Texas folding crate (Fig. 16), and others.

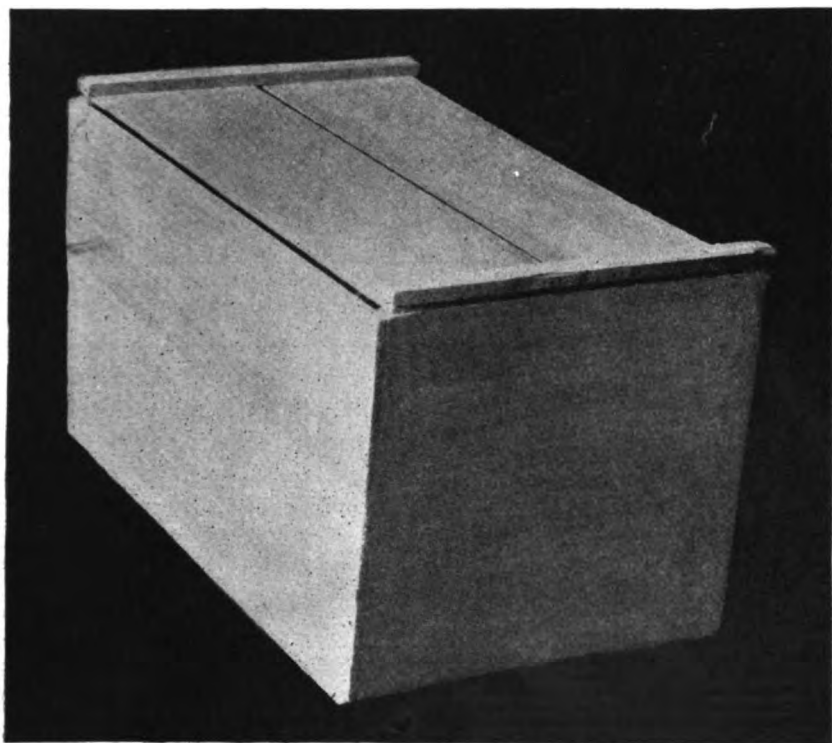


FIG. 17.—Northwestern apple box. Over 35,000,000 of these boxes are used annually.

The problem of standardization must be approached from two angles: First, standards based on the bushel with its multiples and subdivisions for use in shipping products sold extensively by the bushel, and also sold in baskets standardized on the basis of the bushel; and, second, crates of standard dimensions which are not based on volume but on their particular desirability for use in packing certain crops. Under the first division would come crates for such products as potatoes, onions, and apples, and under the second, special crates for cantaloupes, celery, asparagus, and pineapples.

The work of standardization should be carried on with a view to securing uniformity in the case of many boxes and crates of nearly but not exactly the same size.

PRODUCE BOXES.

Produce boxes or lug boxes are commonly used for marketing locally grown farm produce in the city markets. In many localities there is such a serious lack of uniformity in the sizes of these boxes that it is impossible to know the exact capacity, and thus opportunity is afforded for deception. Figure 18 shows a type in use in one eastern city. These boxes are made in sizes varying from 25 to 33 quarts, although they are supposed to contain 1 bushel.

The following table shows the variety of lugs now in use in some of the principal markets of the country:

Produce boxes.

Type.	Inside dimensions (inches).	Capacity (cubic inches).
Rochester, N. Y., box.....	11 by 14½ by 16½.....	2,586
Buffalo, N. Y., box.....	10 by 14½ by 18.....	2,600
Do.....	11 by 14½ by 16½.....	2,586
Huntington, W. Va., box.....	11½ by 14½ by 16½.....	2,704
Do.....	11½ by 13 by 17½.....	2,523
Harrisburg, Pa., box.....	11½ by 13½ by 17½.....	2,716
Detroit, Mich.: Rigid ventilated box.....	12 by 13½ by 16½.....	2,713
Folding box.....	11½ by 14½ by 18½.....	2,754
Columbus, Ohio.....	12½ by 13½ by 14.....	2,406
Milwaukee, Wis.....	9½ by 15 by 18.....	2,565
Cleveland, Ohio.....	8 by 13 by 20½.....	2,136
Do.....	8 by 15 by 18.....	2,160
St. Louis, Mo.....	8½ by 11½ by 22.....	2,182
Providence, R. I.....	7½ by 17½ by 17½.....	2,163
Boston, Mass.....	8 by 18 by 18.....	2,592
Richmond, Va.: No. 3 canned goods box.....	10 by 13 by 17½.....	2,275
Soap box.....	7½ by 14½ by 18½.....	2,012
Washington, D. C.....	6½ by 12 by 22.....	1,716
Do.....	7½ by 13½ by 19.....	1,850
Do.....	7 by 13 by 22.....	2,002
Do.....	6½ by 16 by 21.....	2,268
Philadelphia, Pa.....	15 by 18½ by 20.....	5,625
San Francisco, Calif.: 40-pound lug box.....	7½ by 12 by 20½.....	1,883
50-pound lug box.....	7½ by 14 by 22.....	2,414
60-pound lug box.....	8½ by 14 by 22½.....	2,648
Do.....	9 by 14 by 22½.....	2,804
Los Angeles, Calif.....	5½ by 14 by 16½.....	1,308
Chicago, Ill.....	5½ by 12 by 14½.....	940
Do.....	5½ by 12½ by 16.....	1,100
Do.....	5½ by 12½ by 14½.....	1,019
Buffalo, N. Y.....	5½ by 14 by 15.....	1,207
Providence, R. I.....	6½ by 13 by 13.....	1,090

Attempts to standardize produce boxes on the basis of the weight bushel have been unsatisfactory and have led away from any attempt at uniformity. Some of these boxes hold nearly 5 pecks.

Produce boxes should be standardized on the same basis as fruit and vegetable crates. Two sizes, $\frac{1}{2}$ -bushel and 1-bushel, will meet practically all requirements of the trade, but if larger sizes seem desirable for any particular purpose they should be manufactured in $1\frac{1}{2}$ -bushel size or in multiples of the bushel.



FIG. 18.—Produce or lug boxes varying in size from 25 quarts to 33 quarts. All sell on the wholesale market for the same price.

NOTES ON OTHER CONTAINERS.

The investigations of the Bureau of Markets have covered practically all styles of packages used in marketing fruits and vegetables in the United States. While in many instances these studies have not progressed to a point where it is advisable to make definite recommendations the information which follows serves to point out many opportunities for applying the general principles which have been set forth. There is no doubt that, through intelligent legislation, the number of styles and sizes could be reduced without interfering with the requirements of the industry.

APPLE BOXES.

The northwestern apple box (See fig. 17) is now generally recognized as the standard in all the western apple districts, and with the exception of California, where a special box $9\frac{1}{2}$ by 11 by $20\frac{1}{4}$ inches is also made, it is used almost exclusively. The inside dimensions of the northwestern box are $10\frac{1}{2}$ by $11\frac{1}{2}$ by 18 inches, with a cubic content of 2,173 cubic inches. In the interest of the general problem of standardization, the content of this box might be made to conform to the standard bushel, by reducing the depth from $11\frac{1}{2}$ to $11\frac{3}{8}$ inches without interfering in any way with the present packing methods.

ASPARAGUS CRATES AND BOXES.

Asparagus is marketed in specially-constructed crates and boxes. A very popular type of crate for long stalks of asparagus is pyramidal in form. Asparagus having short stalks is generally marketed in boxes and is either laid on end or placed with the tips

up. Illinois growers use boxes having 20 or 24 compartments similar to the divisions of an egg case. (See fig. 19.) Each compartment contains one bunch of asparagus. The type of crate in most general use in California and South Carolina is a pyramidal crate holding

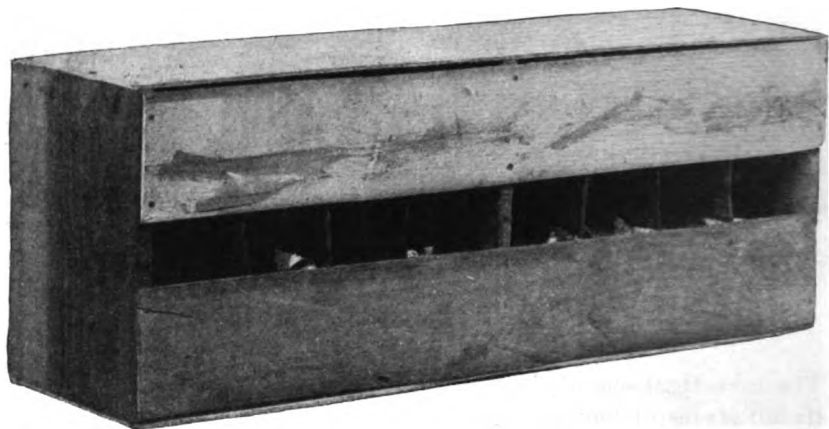


FIG. 19.—Illinois asparagus crate with 24 compartments.

1 dozen bunches. (See fig. 20.) These bunches are placed ends down in moss laid on the bottom of the crate. Occasionally asparagus is shipped loose in this same crate. A small pyramidal crate is used in Illinois, while New Jersey uses larger crates of the same type

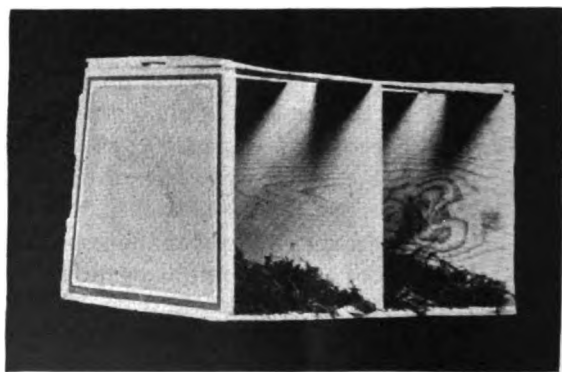


FIG. 20.—California pyramid crate used for asparagus.

holding 2 dozen bunches. Maryland ships in rectangular boxes holding 24 to 36 bunches. It is believed that the pyramidal crate best adapted to marketing asparagus is the California crate. (Fig. 20.) The Illinois compartment box is a satisfactory shipping container and might be standardized in the 24-bunch size. No further con-

clusions have been reached regarding types of asparagus boxes that might be standardized. The following is a list of the various types of asparagus crates in general use in 1920:

PYRAMIDAL ASPARAGUS CRATES.

Type.	Inside dimensions (inches).	Contents.
California.....	(9½ by 11) by 10½ by 17½.....	12 bunches.
South Carolina.....	(9½ by 11) by 10½ by 17½.....	Do.
New Jersey.....	(14½ by 19) by 11½ by 23.....	2 dozen bunches.
Maryland.....	(14 by 16) by 9½ by 24.....	Do.
Delaware.....	(9 by 12) by 10 by 30.....	Do.
Do.....	(9 by 12) by 10 by 24.....	1½ dozen bunches.
Do.....	(9 by 12) by 10 by 14.....	1 dozen bunches.
Washington.....	(6 by 10) by 8 by 18.....	
Illinois.....	(4 by 5½) by 8½ by 20½.....	18 pounds.
Do.....	(3½ by 5) by 8 by 20½.....	
Do.....	(4½ by 5½) by 8½ by 20½.....	
Do.....	(4½ by 5½) by 10½ by 16.....	12 bunches or 18 pounds.

ASPARAGUS BOXES.

California.....	6½ by 15 by 21.....	50 pounds.
Do.....	3½ by 18 by 17.....	20 pounds.
Illinois.....	6 by 8 by 20½.....	2 dozen bunches.
Do.....	6 by 8 by 21.....	Do.
Do.....	4 by 8 by 20½.....	20 bunches.
Do.....	4 by 7½ by 20½.....	Loose.
Maryland.....	10 by 16 by 27.....	28, 32, or 36 bunches.
Washington.....	14 by 3½ by 17.....	15 pounds.

CABBAGE CRATES.

In addition to large sales of cabbage in bulk or by the barrel, cabbage is sold extensively in crates of many varying dimensions and sizes. The following list shows some of the sizes in general use in 1920 with probable point of origin. Many other sizes might be mentioned.

Location.	Inside dimensions (inches).	Outside dimensions (inches).	Capacity (cubic inches).
Coleman, Fla.....	12 by 20 by 33.....	12½ by 20½ by 36.....	7,920
Sanford, Fla.....	12 by 18 by 33.....	12½ by 18½ by 36.....	7,128
New York, N. Y.....	34 by 19 by 11.....	11½ by 19½ by 35½.....	7,106
Yonges Island, S. C.....	10½ by 19 by 37½.....	11½ by 19½ by 39½.....	7,481
Denver, Colo.....	21 by 24 by 22.....	26 by 22½ by 22½.....	11,068
Rural Retreat, Va.....	18 by 23 by 24.....	18½ by 24½ by 24½.....	9,936
Do.....	11 by 23½ by 24.....	11½ by 24 by 24½.....	6,105
Atlanta, Ga.....	18 by 18 by 30½.....	18½ by 18½ by 33½.....	9,882
Marietta, Ohio.....	16 by 16 by 30.....	16½ by 16½ by 31½.....	7,620
St. Paul, Minn.....	15 by 15 by 31.....	15½ by 15½ by 34.....	6,975
Minneapolis, Minn.....	17½ by 17½ by 30½.....	18½ by 18½ by 34.....	9,417
Dyer, Tenn.....	12 by 16 by 22.....	12½ by 16½ by 24.....	4,224
Dallas, Tex.....	20 by 20 by 25.....	21 by 21 by 28.....	10,000
Los Angeles, Calif.....	13 by 18 by 24½.....	13½ by 18½ by 25½.....	5,666
Do.....	18 by 18 by 23.....	18½ by 18½ by 24½.....	7,695
San Francisco, Calif.....	18 by 24 by 20½.....	18½ by 24½ by 24.....	8,964
Do.....	24 by 24 by 21½.....	24½ by 24½ by 24.....	12,240
Puyallup, Wash.....	24 by 24 by 24.....	24½ by 24½ by 25½.....	13,824
Portland, Oreg.....	24 by 19½ by 21½.....	24½ by 22 by 24.....	9,817
Chicago, Ill.....	15 by 15 by 27½.....	16 by 16 by 30.....	6,187



FIG. 21.—Cabbage crate in common use on the Atlantic Coast (12" x 18" x 33").

A study of this table shows that the capacity of most cabbage crates varies from about 6,000 to 9,000 cubic inches. In so far as capacity is concerned, this large number of sizes could be reduced to two or three. The four types included in the following table are the most popular, taking the country as a whole.

Along the Atlantic coast the long narrow crate with a centerpiece is in use for Wakefield cabbage, whereas in the Middle West crates with square ends are in general use for all varieties. (See figs. 21 and 22.) Investigations thus far carried on indicate that further investigations may show other desirable crates.

Type.	Inside dimensions (inches).	Length of slat (inches).	Capacity (cubic inches).
Atlantic Coast type.....	12 by 18 by 33.....	36	7,128
Mississippi Valley type.....	16 by 16 by 28.....	30	7,168
Colorado type.....	21 by 22 by 24.....	24	11,088
California type.....	18 by 18 by 23½.....	24½	7,695

The weight in these crates will vary according to the method of packing and the variety of cabbage marketed. Generally speaking, the Florida, Mississippi Valley, and California types will hold approximately 100 pounds. The Colorado crate will hold about 160 pounds, depending upon the variety.

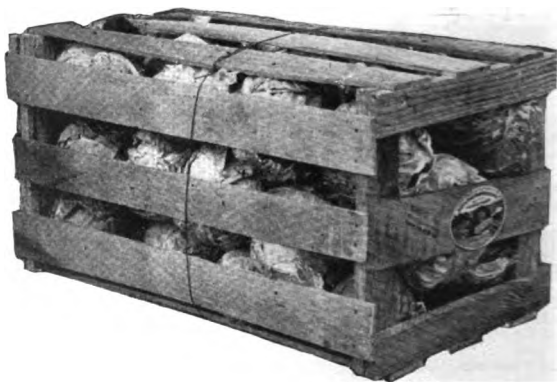


FIG. 22.—Cabbage crate in common use in the Middle West (16" x 16" x 28").

CANTALOUPE CRATES.

Cantaloupes are marketed in special crates (See fig. 23), the dimensions of which are fixed to contain a certain numerical count. Square-end crates hold 36, 45, and 54 melons each, while small crates known as "flats" hold 12 or 15 melons. In the East the large crates are made with paneled ends; in the West the slats forming the heads are nailed to triangular posts. Flat crates from all sections have solid ends. The following types and sizes were in general use in 1920:

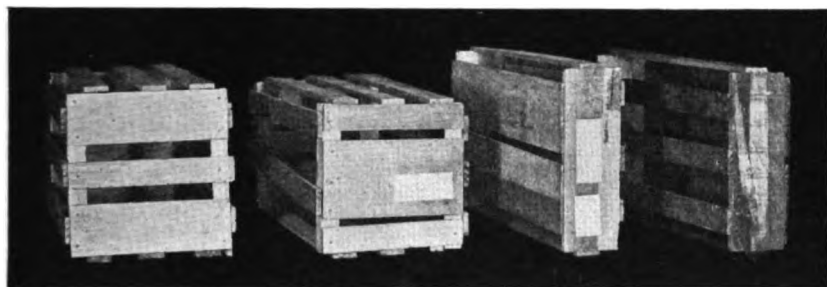


FIG. 23.—Four suggested sizes of cantaloupe crates: Standard, Pony, Standard Flat, and Pony Flat.

Type.	Inside dimensions (inches).	Contents.
Square heads:		
California standard crate.....	12 by 12 by 22½	36 or 45 melons.
California pony crate.....	11 by 11 by 22½	45 or 54 melons.
Eastern pony crate.....	11 by 11 by 22	45 or 54 melons.
Eastern standard crate.....	12 by 12 by 22	36 or 45 melons.
Delaware pony crate.....	10½ by 10½ by 20½	
Delaware jumbo crate.....	14 by 14 by 24	
Norfolk crate.....	10½ by 13 by 26	Jumble pack.
Illinois crate.....	8 by 8 by 16½	16 melons.
Flat crates:		
California standard flat.....	4½ by 13½ by 22½	12 or 15 melons.
California pony flat.....	4 by 12 by 22½	12 or 15 melons.
Colorado special standard flat.....	4½ by 13 by 22½	12 or 15 melons.
Colorado jumbo flat.....	5 by 14½ by 22½	12 or 15 melons.
Georgia flat.....	4 by 12 by 22	12 or 15 melons.
North Carolina flat.....	4½ by 13 by 22½	12 or 15 melons.
Indiana flat.....	4½ by 12½ by 17	
Indiana flat.....	4½ by 13½ by 21	

The large number of sizes given could be readily reduced to six, possibly to four types of crates without interfering with the standard pack. (See fig. 23.)

The suggested sizes are:

Standard	inches..	12	by	12	by	22½
Pony	do.....	11	by	11	by	22½
Standard flat	do.....	4½	by	13½	by	22½
Pony flat	do.....	4	by	12	by	22½
Jumbo	do.....	13	by	13	by	22½
Jumbo flat	do.....	5	by	14½	by	22½

CAULIFLOWER CRATES.

Crates are used extensively in marketing cauliflower. Barrels are too large and do not supply sufficient ventilation and baskets are not satisfactory. In California a standard crate holding from 2 dozen to 2½ dozen heads of cauliflower and a pony crate holding 12 to 15 heads are in general use. In western New York a rectangular crate 8 by 18½ by 20½ inches and a cradle crate (13½ by 18 inches) by 8 by 23½ inches are popular. A cradle crate affords better ventilation in loading, as spaces are left between the crates. The Long Island crate is not so satisfactory to the trade as the other crates. The following list contains many of the sizes in general use in 1920:

Type.	Inside dimensions (inches).	Capacity.
Standard California crate.....	13 by 18 by 21½.....	5,118 cubic inches.
Pony.....	8½ by 18 by 23½.....	3,538 cubic inches.
Oregon flat crate.....	8 by 18 by 23½.....	3,384 cubic inches.
Oregon special crate.....	13 by 18 by 26½, outside.....	
Western New York crate.....	8 by 18½ by 20½.....	2997.
New York cradle crate.....	(13½ by 18) by 8 by 23½.....	12 to 14 heads.
Long Island crate.....	13 by 15 by 23.....	4,485 cubic inches.
New York crate.....	13½ by 16 by 23½.....	5,022 cubic inches.
Colorado crate.....	21 by 25 by 22.....	125 to 150 pounds.
Do.....	10 by 21 by 26.....	60 to 70 pounds.
Colorado cradle crate.....	14 by 17½ by 8 by 26.....	1 dozen.

CELERY CRATES AND BOXES.

Celery must of necessity be marketed in special crates. The size of the crate will, in part at least, depend upon the variety and size of the celery plant. The bottoms of celery crates can be readily standardized, but it may be necessary to vary the depth to provide for stock of various sizes. A few of the various types of crates in general use in 1920 are given in the following table:

Celery crates and boxes.

Type of container.	Inside dimensions (inches).	Type of container.	Inside dimensions (inches).
Florida standard.....	10 by 20 by 22	Texas crate.....	19 by 22 by 21
Manatee crate.....	12 by 18 by 22	California 18-inch crate.....	18 by 22 by 21
Michigan highball.....	10 by 12 by 18	California 20-inch crate.....	20 by 22 by 21
Michigan special highball.....	12 by 15½ by 18	California 22-inch crate.....	22 by 22 by 21
New York special.....	20 by 21 by 23	Colorado crate.....	21 by 22 by 21
New York standard crate.....	21 by 21 by 23	New Jersey crate (oblong).....	18 by 20 by 23
New York crate.....	22 by 22 by 23	Ohio crate.....	14 by 18 by 21
Do.....	22 by 22 by 22	Kalamazoo crate.....	6 by 14 by 21
Oregon 18-inch crate.....	18 by 22 by 23	Decatur box.....	6 by 14 by 21
Oregon 20-inch crate.....	20 by 22 by 23	Grand Haven box.....	9½ by 9½ by 17
Oregon 22-inch crate.....	22 by 22 by 23	Hudsonville box.....	9 by 9 by 17

Florida growers have adopted a standard celery crate, 10 by 20 by 22 inches, which is proving satisfactory. (See fig. 25.) Celery crates in general use in Colorado, California, New York, and New Jersey could readily be standardized, as they vary but slightly in size or shape. (See fig. 24.) Michigan crates and boxes appear to show no indications of standardization. The

paneled end of Michigan crates have the dimensions 12 by 18 inches. Slats are used with this head or panel from 8 to 28 inches

in length in steps of 2 inches each, that is, 10, 12, 14, etc. This makes about 11 sizes of crates having a 12-by-18-inch end.

Boxes are used with ends 6 by 8 inches, 6 by 10 inches, 6 by 12 inches, and so on up, in 2-inch steps, to about 6 by 20 inches, making the same number by different sizes of ends, with veneer to suit the individual fancy of the shippers. Certainly this number could be greatly reduced.

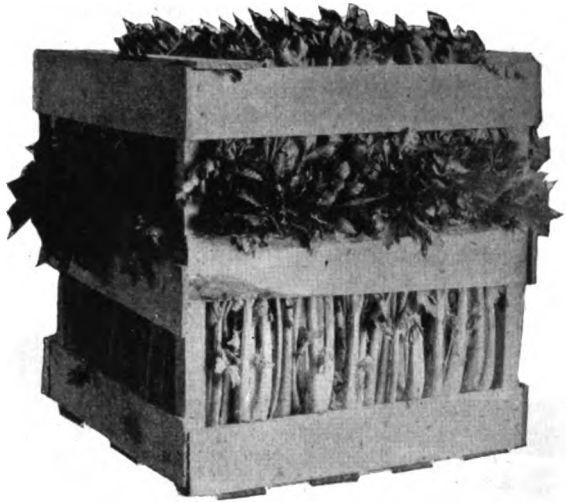


FIG. 24.—Colorado celery crate (19½" x 21" x 27"). The celery crates used in California, New York, and New Jersey are similar to this crate.

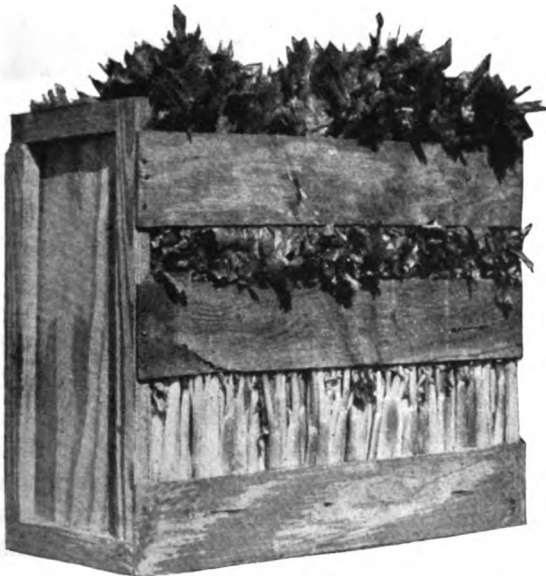


FIG. 25.—Florida celery crate (10" x 20" x 22").

CITRUS BOXES.

There are two orange boxes in common use—the California box, which holds approximately 1.47 bushels, and the Florida box, which contains 1.6 bushels. (See fig. 26.) Both boxes are well established by custom and the difference in capacity is recognized everywhere by the trade. The establishment of a uniform standard is of little interest to the public, as citrus fruit is packed and sold by numerical count rather than by measure. The orange box is used for grapefruit as well.

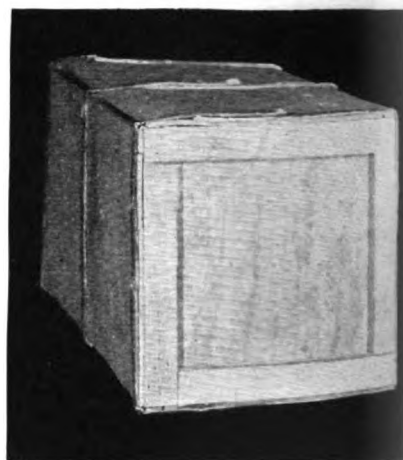
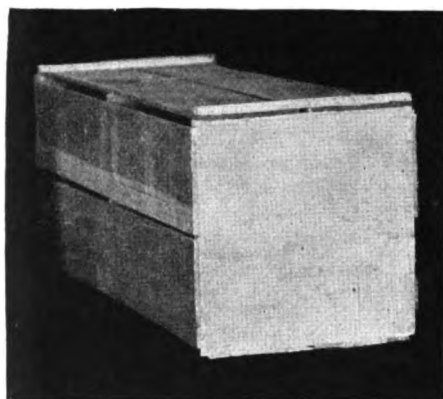


FIG. 26.—The California orange box (left) holds 1.47 bushels or about 4 quarts less than the Florida orange box (right).

Type.	Inside dimensions (inches).	Capacity (cubic inches).
California orange box.....	11½ by 11½ by 24.....	3,174
Florida orange box.....	12 by 12 by 24.....	3,456
Florida tangerine box.....	6 by 12 by 24.....	1,728
California lemon box.....	10 by 13 by 25.....	3,250
California Jumbo lemon box.....	11½ by 13½ by 25.....	3,754
Italian lemon box.....	10½ by 13½ by 25.....	3,544

CHERRY BOXES.

Western cherries are shipped in boxes. The types in most general use are 10-pound and 20-pound boxes. (See fig. 27.) A 15-pound lug box for a loose pack is also used in some sections of California. Inside dimensions of these boxes are as follows:

10-pound box.....	2½ by 9 by 18 inches.
20-pound box.....	4½ by 9 by 18 inches.
15-pound cherry lug.....	4½ by 11½ by 18 inches.

These sizes are now standardized by law in California.

CRANBERRY BOXES.

Cranberries are marketed in boxes of several sizes, as well as in the standard cranberry barrel. A 50-pound box, holding one-half barrel, is popular. The capacity of this box is a trifle over 44 quarts. In the interest of crate standardization this box might be readily increased in size to $1\frac{1}{2}$ bushels.

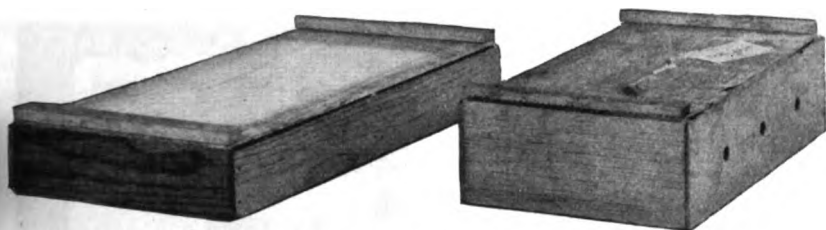


FIG. 27.—California 10-pound and 20-pound cherry boxes.

The so-called bushel box for cranberries, standardized by State law in New Jersey and Massachusetts, is a short bushel, holding 1,980 cubic inches. It holds somewhat over one-third of a cranberry barrel. This crate should be increased in size to 1 bushel. A special 21-pound cranberry crate, holding about 20 quarts, is used by the New York trade. The inside dimensions of cranberry boxes are as follows:

Type.	Inside dimensions (inches).	Capacity (cubic inches).
50-pound box	11 $\frac{1}{2}$ by 13 by 20.....	2,990
Jersey box	12 by 7 $\frac{1}{2}$ by 22.....	1,980
21-pound New York box.....	10 $\frac{1}{2}$ by 6 $\frac{1}{2}$ by 20 $\frac{1}{2}$	1,380

GRAPE CONTAINERS.

Climax baskets (Fig 6) and a four-basket square crate, containing four 3-quart baskets, are used extensively for marketing grapes. Climax baskets are popular in the East, and the four-basket square crate on the Pacific coast. Delaware grapes are marketed in an eight-basket carrier crate, each basket holding 2 quarts. The lug box is used very extensively in the West for wine grapes. These lugs are made in several sizes, designed to hold from 25 to 40 pounds of grapes. Emperor grapes from California are shipped in kegs and drums holding 2,923 cubic inches. The drum has a 15 $\frac{1}{2}$ -inch head and is 14 inches between heads.

Grape boxes and crates.

Type.	Inside dimensions (Inches).	Capacity.
Pacific Coast 4-basket square crate.....	44 by 16 by 16.....	Four 3-quart baskets.
Delaware 8-basket crate.....	8 by 10½ by 21½.....	Eight 2-quart baskets.
New York 8-basket crate.....	8½ by 7 by 19.....	Eight 1-quart baskets.
Los Angeles lug box.....	5½ by 14 by 16½.....	1,308 cubic inches.

LETTUCE CRATES AND BOXES.

Lettuce is marketed in about 30 styles of crates and boxes. In addition, some sections of the country use baskets and barrels. Toledo gardeners market leaf lettuce in second-hand vegetable, flour, and sugar barrels. Cleveland uses a 24-quart veneer basket, holding 10

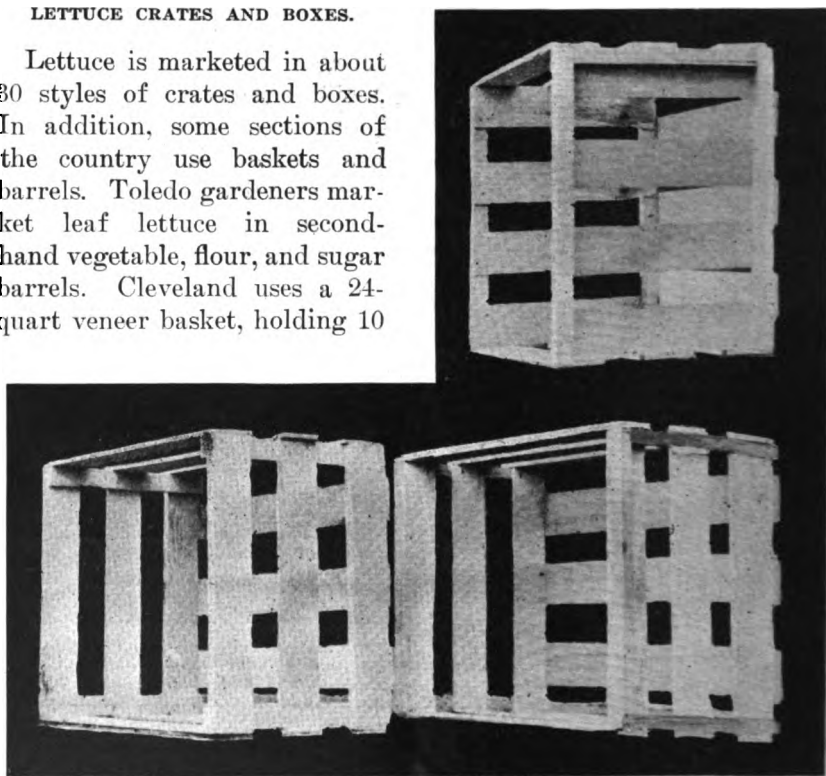


FIG. 28.—California lettuce crates hold 3 to 5 dozen heads of lettuce.

pounds of leaf lettuce. Ashtabula growers use a 14-quart square-cornered splint basket, containing 3 pounds of lettuce. New York uses a 2-dozen crate (See fig. 29) for No. 1 head lettuce and a 44-quart hamper for No. 2 lettuce. Florida shippers use a tall lettuce hamper, in sizes varying from 5 to 6 pecks. A crate holding 2 to 2½ dozen heads, slightly larger than the New York crate, is also used. New Jersey uses a 2-dozen crate. California ships in a crate 13 by 18 by 22½ inches, holding from 3 to 5 dozen heads, according to size. Vin-

cennes, Ind., uses a three-fourths bushel round basket, holding 10 pounds of leaf lettuce, and a standard bushel basket holding approximately 15 pounds of lettuce. Colorado uses crates holding 3, 5, and 8 dozen heads. St. Louis uses a lug box locally, and Illinois growers seem to favor the use of a smaller box, holding from 2 to 4 pounds of lettuce. The dimensions of these and other crates are given in the following table:

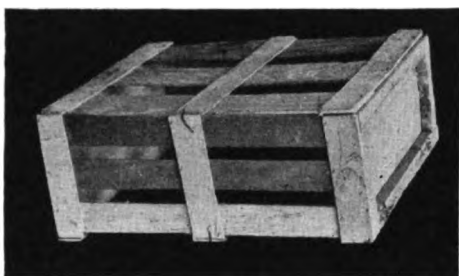


FIG. 29.—New York 2-dozen lettuce crate.

Type.	Inside dimensions (inches).	Contents.	Capacity (cubic inches).
California standard crate.....	13 by 18 by 22½	3 to 5 dozen.	5,177
California short crate.....	12 by 18 by 22½	do.	
Do.....	13 by 17 by 22½	do.	
Arizona crate.....	8½ by 18 by 22½	4 dozen.	3,442
Salt Lake City crate.....	10 by 13½ by 24½	2½ dozen.	3,307
California special crate.....	10 by 13½ by 18	2 dozen.	2,430
Brasley, Calif., crate.....	13 by 18 by 21½	3 to 5 dozen.	
Seattle crate.....	10½ by 14 by 30½		4,465
Washington crate.....	15½ by 18 by 23½		6,556
Tacoma, Wash., crate.....	15½ by 18 by 23½		6,626
St. Louis crate.....	6½ by 11 by 21½	16 heads.	1,530
New York crate.....	7½ by 16½ by 20	2 dozen.	
Do.....	8 by 16½ by 20	do.	
Do.....	7½ by 16½ by 19	do.	2,351
Chicago box.....	5 by 8 by 15½	2 to 4 pounds	610
Bridgeton, N. J., crate.....	8 by 15½ by 22½	2 dozen.	2,790
Buffalo crate.....	7½ by 18 by 22	do.	2,970
Do.....	8½ by 16 by 20½	do.	
Do.....	8½ by 15 by 20½	do.	
Do.....	7½ by 16 by 20½		
Florida crate.....	7½ by 18 by 22	2 to 2½ dozen.	
Oregon crate.....	7½ by 10½ by 15	5 pounds.	
Denver crate.....	15 by 16 by 22	3 dozen.	
Do.....	15 by 21 by 24	5 dozen.	
Do.....	21 by 22 by 25	8 dozen.	
Texas crate.....	7½ by 13½ by 24½	2 dozen.	
Do.....	10½ by 13½ by 24½	2½ dozen.	
Do.....	10½ by 18 by 22½	5 dozen.	
Do.....	15½ by 18 by 22½	6 dozen.	

A study of the dimensions of these crates shows that many are similar in size. There appears to be a very strong demand for a crate holding 2 dozen heads of lettuce. The dimensions of the 2-dozen crate could certainly be readily standardized. There is also considerable call for a lettuce crate holding from 3 to 5 dozen heads. The California standard crate, with the inside dimensions 13 by 18 by 22½ inches, is suggested as a possible standard crate in the larger size. (See fig. 28.)

PEACH BOXES.

The western peach box has been standardized as to length and width by trade custom. (See fig. 30.) These two dimensions are identical with those of the western apple and pear boxes, which facilitates the loading of car lots of mixed fruits. The peach boxes are manufactured in several depths, varying from $3\frac{1}{2}$ to $5\frac{1}{2}$ inches. The $3\frac{1}{2}$ -inch size is used for packing prunes, and when so employed is known as the "suitcase."

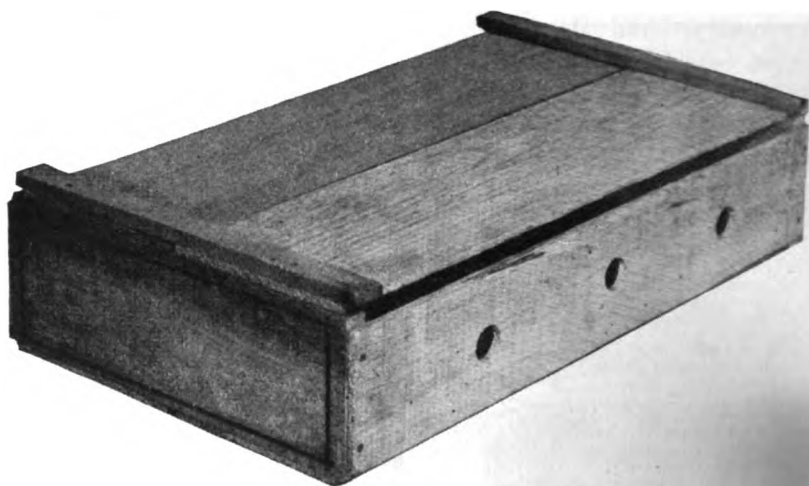


FIG. 30.—Western peach box.

PEAR BOXES.

The standard pear box of Washington and California is now in almost universal use. The inside dimensions of this box are $8\frac{1}{2}$ inches deep, $11\frac{1}{2}$ inches wide, and 18 inches long.

PEPPER CRATES.

A special crate with cleated sides and solid top and bottom is in general use for shipping peppers and eggplant. (See fig. 32.) This crate holds about $1\frac{3}{4}$ bushels and generally has the following dimensions: Fourteen inches wide, 11 inches deep, and 22 inches inside length. The heads are also manufactured in two other sizes— $14\frac{1}{2}$ by 11 inches and $14\frac{1}{2}$ by $11\frac{1}{4}$ inches. If this crate were to be standardized on the same basis as baskets, it might be made $13\frac{3}{4}$ by 11 by 22 inches, inside measurements, with a cubic content of $1\frac{1}{4}$ bushels.

PINEAPPLE CRATES.

Pineapples are marketed in two styles of crates. The crates used in Florida, Cuba, and the Isle of Pines contain two compartments. The inside dimensions are $10\frac{1}{2}$ by 12 by 33 inches; capacity, 4,158 cubic inches.



FIG. 31.—Hawaiian pineapple crate.

The heads are paneled, and two slats, 36 inches in length, are used on the sides, top, and bottom. The Hawaiian pineapple crate has octagonal heads. (See fig. 31.)

TOMATO CRATES.

In addition to marketing tomatoes in 6-basket carrier crates, 4-basket Mississippi flats, Climax baskets, five-eighths bushel truck baskets, three-fourths bushel, and bushel round stave baskets, several types of crates and boxes are in general use. (See fig. 33.) In New Jersey tomato growers use a tomato crate with a raised top or lid. Formerly this crate held about 27 quarts, but it is now made to contain 20 quarts.

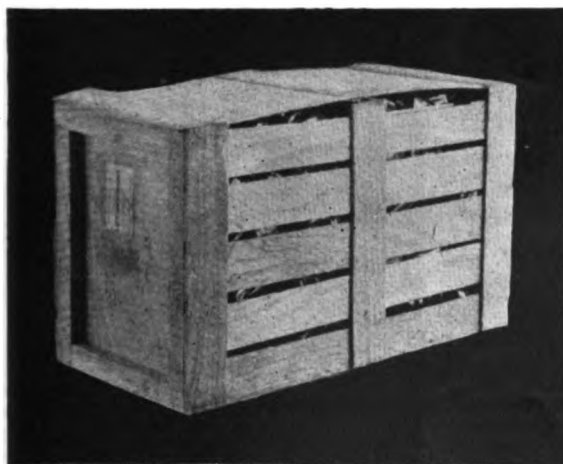


FIG. 32.—Pepper crate, capacity $1\frac{1}{2}$ bushels, should be reduced to $1\frac{1}{4}$ bushels in the interest of standardization.

In the West a tomato lug box is in common use. This lug box has heads $5\frac{1}{2}$ by 14 inches and is $16\frac{1}{4}$ inches long inside. The following tables gives the dimensions and capacities of tomato crates and boxes in general use in 1920:

Type of container.	Inside dimensions (inches).	Capacity.
20-quart New Jersey crate.....	6 $\frac{1}{2}$ by 11 by 18 $\frac{1}{2}$	1,373 cubic inches.
27-quart New Jersey crate.....	9 by 11 by 18 $\frac{1}{2}$	1,831 cubic inches.
California lug box.....	5 $\frac{1}{2}$ by 14 by 16 $\frac{1}{2}$	1,308 cubic inches.
6-basket carrier crate.....	10 by 11 by 22.....	Six 4-quart baskets.
4-basket flat crate.....	11 $\frac{1}{2}$ by 13 $\frac{1}{2}$ by 4 $\frac{1}{2}$ by 20 $\frac{1}{2}$	Four 3-quart baskets.

PROGRESS IN STANDARDIZATION.

Since the passage of the Federal standard barrel Act, in 1915, there has been a steady progress in the work of eliminating unnecessary and deceptive sizes from the list of containers used in marketing fruits and vegetables. The passage of the United States standard container Act, establishing standards for grape baskets, berry boxes, and small till baskets, followed in 1916. At the present time a bill is pending in Congress which if it becomes a law will provide standards for three other important marketing containers—the round stave basket, the hamper, and the splint or market basket. The entire industry has given whole-hearted support to the general principle, and the problem which now remains is that of determining which containers should be abolished and which should be retained.

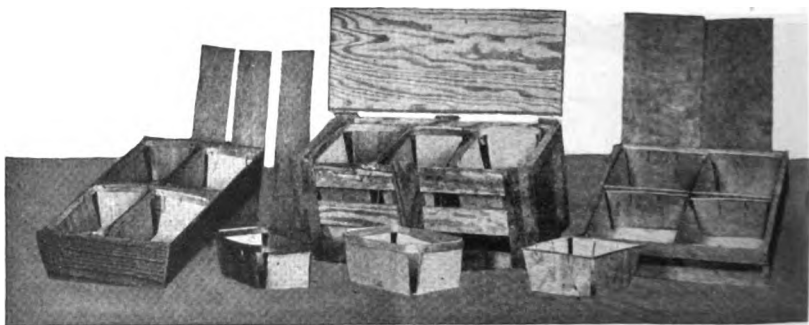


FIG. 33.—Crates used for tomatoes, peaches, and other small fruits. Left: 4-basket crate from Mississippi and Texas. Center: 6-basket carrier crate for tomatoes and peaches. Right: 4-basket western grape crate.



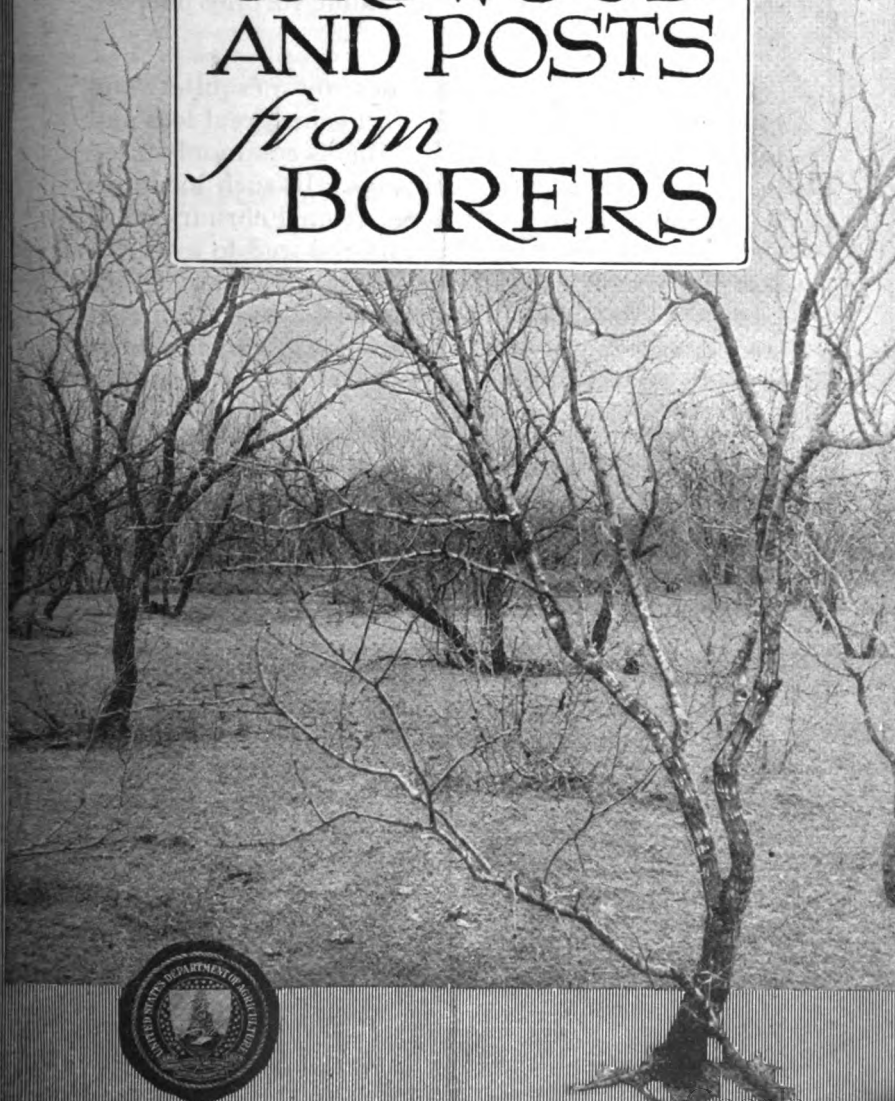
**A MOTLEY ARRAY
WHO KNOWS WHICH?**



71.9: 1197
FARMERS' BULLETIN --1197
UNITED STATES DEPARTMENT OF AGRICULTURE



Protection of
**MESQUITE
CORDWOOD
AND POSTS**
from
BORERS



MESQUITE is used throughout the southwestern United States for many purposes, the most important of which are fuel and fence posts. In many sections it is the only tree available for any purpose whatever.

Certain borers completely destroy mesquite wood in a few months after it is cut, causing great loss and inconvenience. Wood cut for fuel is commonly piled in wood yards or along railways. In such locations it is subject to borer damage from February until October and is not infrequently reduced to a worthless pile of sawdust and honey-combed sticks. Fence posts are damaged by sapwood-feeding forms in such a way that staples become loose and the posts must be constantly replaced.

It has been found that by cutting fuel wood at certain seasons and turning more valuable products in the sun practically all insect damage can be prevented.

PROTECTION OF MESQUITE CORDWOOD AND POSTS FROM BORERS.

By F. C. CRAIGHEAD,¹ *Specialist in Forest Entomology*, and GEORGE HOFER,
Entomological Ranger.

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IMPORTANCE OF THE MESQUITE.

Two or three species of mesquite (figs. 1, 2) occur in the southwestern United States and many more are widely distributed throughout the world. Mesquite's adaptation to arid climates makes it an extremely useful tree. In many countries it is chiefly valuable for the food product derived from the bean, although in the United States this is but little exploited at present. In much of the Southwest it is the only available wood.

All of the species or varieties occurring in the Southwest are put to many uses. The wood, being close-grained, hard, heavy, and very durable, makes excellent fence posts, frames for adobe houses, and, to a limited extent, mine props and crossties. The large roots and thickened bases of the stems furnish the best available fuel of this region.

The wood of all varieties of mesquite is the favored food of many borers, which completely riddle it and render it practically worthless a few months after it is cut. Some destroy the sapwood and honeycomb the heartwood within five months (fig. 3); others reduce the sapwood almost to dust within four months (fig. 4) so that fence staples drop out and let the wires down, necessitating constant replacing of the posts. It is not uncommon to see piles of cordwood so riddled that the individual sticks are easily broken and the spaces between the sticks are completely filled with boring dust. Dealers in mesquite fuel suffer considerable losses through such insect damage.

¹ Resigned Dec. 31, 1920.

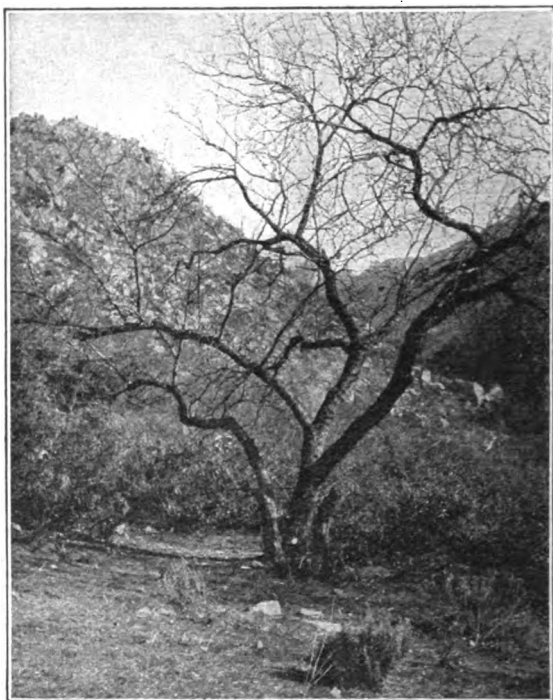


FIG. 1.—An average sized mesquite tree, showing characteristic form. Sabino Canyon, Catalina Mountains, Ariz.

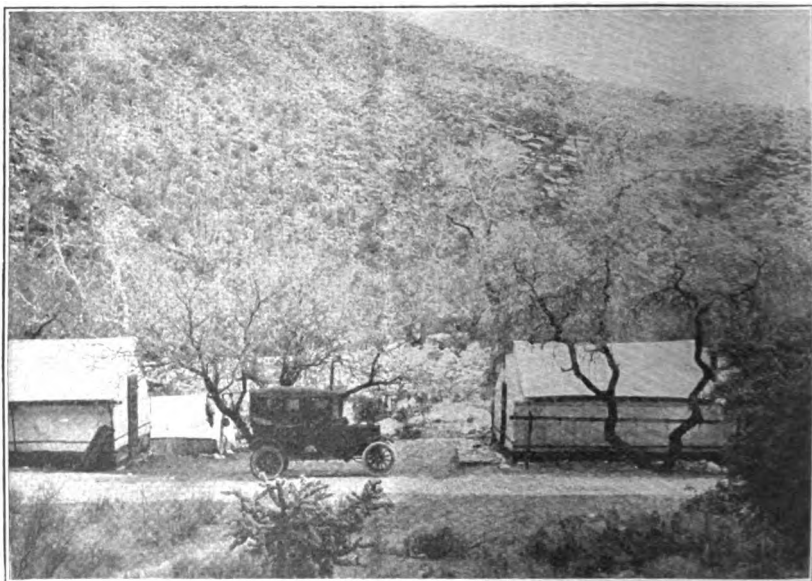


FIG. 2.—Forest Insect Field Station, Sabino Canyon, Catalina Mountains, Ariz. The trees growing close to the tents are mesquites.

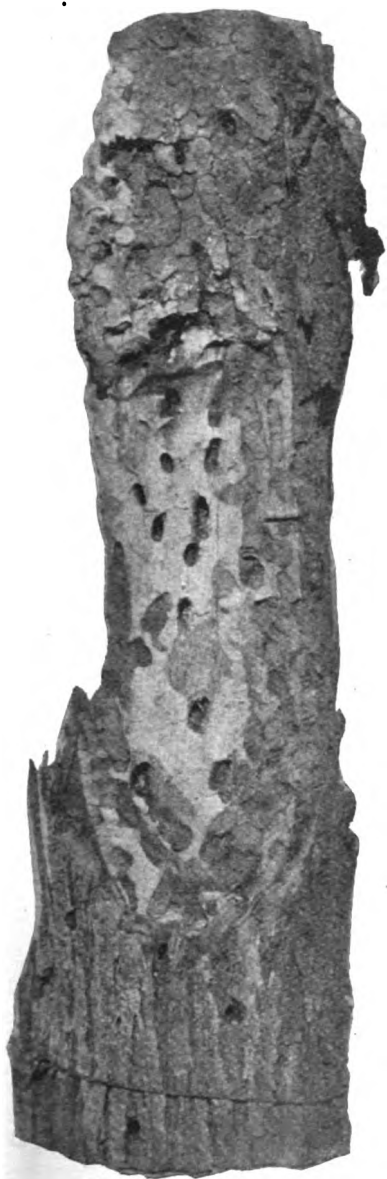


FIG. 3.—Section of mesquite wood five inches in diameter, showing the sapwood destroyed and the honey-combed heartwood six months after attack by the roundheaded borer.



FIG. 4.—Section of mesquite stick after four months work by smaller powder-post grubs, showing depth to which sapwood is eaten. The small holes in the bark are made by the adults which have emerged.

INSECTS RESPONSIBLE FOR THE DAMAGE.

Although many different insects feed in the mesquite, not more than five or six are responsible for most of the injury in any locality, being numerically the more abundant or causing the greater damage by the character of their work.

These insects, according to their structure and the character of their work, may be grouped into three types or classes—namely, roundheaded borers, powder-post beetles, and flat-headed beetles. In the vicinity of Tucson, Ariz.,¹ where the experiments were conducted on which the results of this paper are based, there is only one round-



FIG. 5.—Adult beetle of the roundheaded borer in mesquite.
Enlarged.

headed borer² of much economic importance, but this is the most destructive insect in mesquite. Three powder-post beetles are found, a large,³ a medium,⁴ and a small⁵ form. One flat-headed borer⁶ has been found to cause considerable injury.

CHARACTERISTICS OF THE INSECTS AND THEIR WORK.

All these insects have several distinct forms, known as the egg, the larva, the pupa, and the adult stages, but it is only the larval or

¹ In Texas another species of roundheaded borer (*Cyllene crinicornis* Chev.) and several other species of powder-post beetles (*Xylobiops* spp.) are equally numerous. Their habits are much the same and similar methods of treatment are effective.

² *Cyllene antennatus* White (Figs. 3, 5-8.)

³ *Apatides fortis* Lec. (Figs. 9, 12.)

⁴ *Dendrobiella aspera* Lec. (Figs. 4, 11, 13, 14.)

⁵ *Xylobiops* sp. (Figs. 4, 14.)

⁶ *Chrysobothris octocola* Lec. (Figs. 8, 10, 15.)

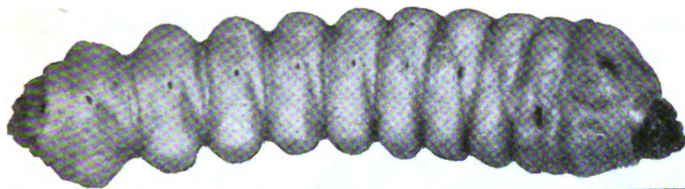


FIG. 6.—Larva, grub, or boring stage of the roundheaded borer in mesquite. Enlarged.



FIG. 7.—Section of mesquite with bark removed, showing larval mines and exit holes of the roundheaded borer.



FIG. 8.—Mesquite stick with bark removed, showing larval mines of the roundheaded and flat-headed borers.

grub form that is responsible for the destruction of the wood. In all cases these larvæ hatch from eggs laid by the adult beetles. Some of these beetles are rarely seen, as they lie concealed during the day and deposit their eggs at night.

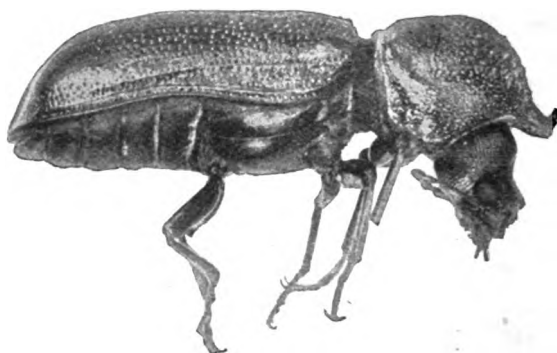


FIG. 9.—Adult beetle of the large powder-post borer in mesquite. Enlarged.

The adult round-headed borer (fig. 5) is a rather large beetle, slightly tapering behind, brown and gray mottled, one-half to one and one-quarter inches long, with quite long flexible horns. It places the eggs in crevices or under scales of the bark. From these eggs

hatch tiny grubs that grow into rather large cylindrical borers (fig. 6), from three-quarters to one and one-half inches in length, yellowish white in color, and with a pair of strong brownish jaws. This is the largest of the borers in recently cut wood. The damage to the wood begins after these grubs hatch and bore in through the bark and sapwood, feeding as they go (figs. 3, 7, 8). They spend from 40 to 60 days mining in the sapwood, reducing it almost to powder, and then enter and honeycomb the heartwood by excavating long, oval galleries. Two months or more pass before there is any external evidence to show that the wood is seriously damaged. The boring dust expelled through a hole in the outer bark is the first and outward evidence of damage. This hole is enlarged as the borer increases in size, and through it the beetle finally emerges (fig. 7). This borer shows a preference for freshly cut wood, but has been known to attack wood cut five months, especially large limbs or sections of the trunk when they are in contact with the ground. It is the most destructive of the mesquite insects. The fact that a stick 4 inches by 2 feet contained over 60 of these large borers illustrates how thorough a honey-combing takes place.



FIG. 10.—Adult beetle of the flat-headed borer in mesquite. Enlarged.

The powder-post borers, as adult beetles (figs. 9, 11), are small to medium sized, short, cylindrical, dark brown to black, and hard shelled. The smaller forms bore through the bark and around the

stem, laying eggs along this tunnel; while the larger form lays its eggs under scales of bark, as do the roundheaded borers. The grubs (figs. 12, 13) which develop from these eggs are curled like a closed finger, so that the head and the end of the body almost meet. They are thicker at one end, and range from one-quarter to three-quarters of an inch in length. The smaller forms appear in enormous numbers, completely riddling the sapwood with cylindrical holes tightly packed with fine powder that falls out when disturbed. By the time they are full grown they have almost destroyed the sapwood (figs. 4, 14). The grub of the larger form feeds only a short

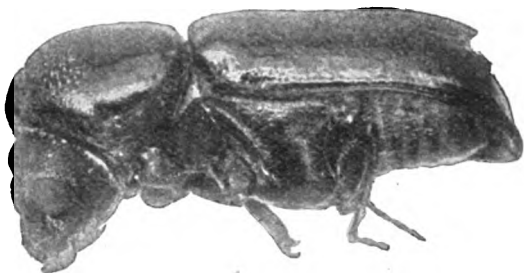


FIG. 11.—Adult beetle of the medium-sized powder-post borer in mesquite. Enlarged.



FIG. 12.—Larva, grub, or boring stage of the large powder-post beetle in mesquite. Enlarged.

while in the sapwood and then goes into the heartwood, where most of the feeding is done. It seldom attacks freshly cut wood, but shows a decided preference for older and drier sticks and posts. It has only one generation each year.

The flat-headed borer, as an adult beetle (fig. 10), is hard shelled, flattened, oval, from one-half to three-quarters of an inch in length, and shining bluish black with light golden yellow spots on top. It lays its eggs on the bark. From these develop flattened yellowish white hammer-shaped worms (fig. 15), having the head end of the body much wider than the remainder.

The larvæ mine between the bark and wood, grooving the sapwood with winding galleries until nearly full grown. (Fig. 8.) These mines are flattened in cross section and filled with fine, tightly packed "sawdust" that does not easily fall out, and when it does so loosens in cakes.

SEASONAL ACTIVITY OF THE BORERS.

There is practically no month of the year in southern Arizona when some few of these beetles do not fly about seeking new wood



FIG. 13.—Larva, grub, or boring stage of the medium-sized powder-post beetle in mesquite. Enlarged.

on which to lay their eggs. During certain periods, however, their number is almost negligible.

The roundheaded borer has two generations a year and two periods during which the beetles are abundant. The overwintering forms mature and the adults emerge and fly chiefly during March and April. From these originates the summer generation, which develops in five months, the beetles emerging in August and September.

The powder-post borers fly as adults more or less during the entire year, although during November, December, and January very few are to be found. The medium and the smaller forms are most abundant from April to September, and during this time they develop very rapidly, producing two or three generations a year. During the hot part of the summer adult beetles develop from eggs in 60 to 70 days. The large powder-post beetle is active from July to September, having only one well-defined generation in a year.

The flat-headed borer flies about from March to October, being most abundant in April, May, and June. There is apparently only one main generation a year, although some develop more slowly than others, thus extending the period during which the beetles fly.

CONDITIONS FAVORABLE AND UNFAVORABLE FOR ATTACK.

The large powder-post beetle prefers wood which has dried out for several months, but all the other borers show a decided preference for freshly cut wood on which to lay their eggs. Some exceptions have been noted, but this is the general rule. Wood which is cut in the fall and seasoned during the winter months is very unattractive in the spring months when the beetles are flying about in search of suitable material for the development of their broods.

It has also been found that only the underside of logs or branches, or those pieces of wood not in the direct sunlight, are selected for feeding. During the greater part of the year the sun heats the upper surface so much that it is impossible for anything to live on it.

METHODS OF PREVENTING INJURY.

Upon a knowledge of the habits and seasonal activities of these insects must depend any method for combating them. It has been shown that during certain seasons of the year few of these insects fly about, that they do not like seasoned wood, and that they can not live beneath bark exposed to direct sunlight. Taking advantage of these factors, the following methods have been tried for preventing damage by them and have proved very successful for all practical purposes.



FIG. 14.—Mesquite stick showing exit holes of the medium and small powder-post beetles.

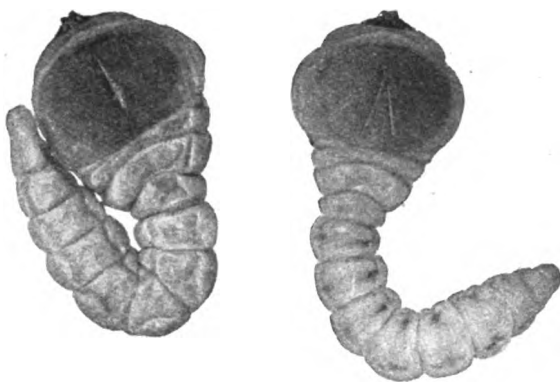


FIG. 15.—Larva, grub, or boring stage of the flat-headed borer in mesquite shown from above and below. Enlarged.



FIG. 16.—"Wigwam" method of piling mesquite cordwood. This type of piling is best, if the cutting is done between October 15 and December 15. It permits rapid seasoning of the wood during the period when the insects are not flying.

Except for immediate use mesquite cordwood should not be cut during the spring and summer months. Wood which is cut between the middle of October and the latter part of January and which is loosely ricked (figs. 16, 17), so that it quickly dries, is usually but little injured. The safest period, however, is from the middle of October to the end of November. Wood should not be stored longer than one year, after which much damage is done by the large powder-post beetle.

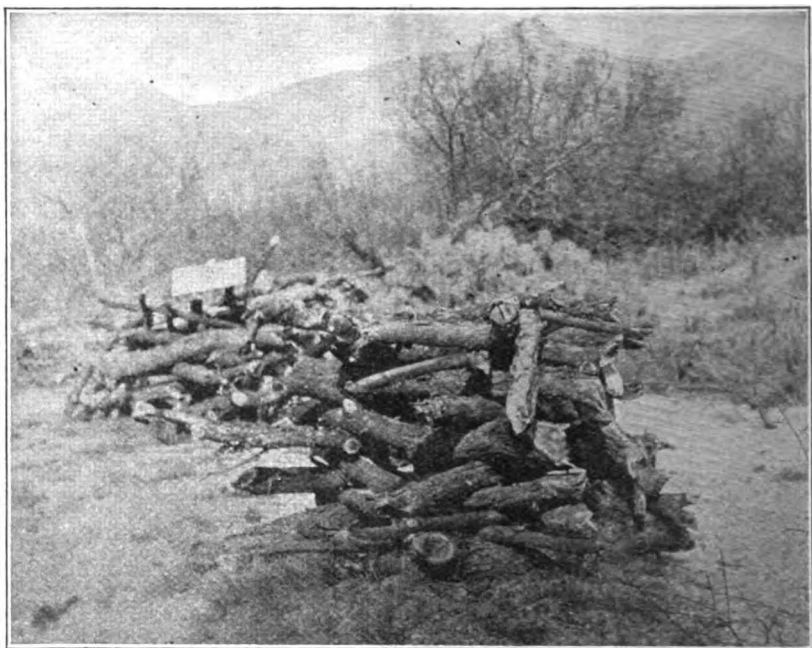


FIG. 17.—Mesquite ricked in open cribs, permitting of rapid seasoning. This is done in late fall and winter before the insects fly.

It has been found that extreme heat prevents attack and kills the grubs which may be in the sapwood. Therefore, the best method for treating posts and more valuable material that has to be cut between March and October is to lay them flat on the ground in the sunlight, then after two weeks turn bottom side up, and repeat the turning two weeks later. Two turns in six weeks are sufficient to kill the grubs or prevent attack. This method can be used effectively only between April 1 and October 1.

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FARMERS' BULLETIN - 1198
UNITED STATES DEPARTMENT OF AGRICULTURE

SWARM CONTROL



WHEN honey is produced on an extensive scale it becomes necessary to distribute the colonies of bees in several apiaries to avoid overstocking. A serious problem when bees are kept in out-apiaries is the control of swarming.

Swarm control is less difficult in the production of extracted honey than of comb-honey. It is less troublesome in some locations than in others and during some seasons than during others. The reasons for these differences are important in the devising of measures for swarm prevention.

The tendency to swarm can be reduced by the introduction of superior stock, by the use of well-arranged hives and good combs, and by management which prevents a congestion of bees in the brood-nest. Swarming, therefore, can be prevented to a large extent by proper equipment and management.

The conditions which reduce the congestion in the brood-nest (preventive measures) are at the same time the conditions which induce the bees to work with the greatest energy in gathering nectar. When remedial measures are employed, the manipulation is such that the colony is thrown into a condition comparable either to the swarm or to the parent colony in nature.

These and other phases of the swarming problem are discussed in this bulletin.

Contribution from the Bureau of Entomology

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Washington, D. C.

June, 1921

SWARM CONTROL.

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SUCCESSION OF EVENTS IN NATURAL SWARMING.

A COLONY OF BEES that is normal and prosperous increases its brood in the spring as its adult population increases, either until all the space available for brood-rearing is occupied or until the queen reaches the maximum of her capacity in egg laying. At first only worker-brood is reared; but as the colony increases in strength the rearing of drone-brood is begun, thus providing for male bees in anticipation of swarming. Finally, when the brood-nest becomes crowded with emerging and recently emerged young bees and the combs are well filled with brood, if nectar in sufficient quantity is available, several queencells are started and eggs are placed in them, this being the first definite preparation for swarming. About nine days from the time the eggs are laid the queen larvæ have developed to the point at which the queencells are sealed, and this is about the time the swarm usually issues. The exact time

of the issuing of the swarm depends to some extent upon the weather, issuing sometimes being postponed by inclement weather and sometimes, especially in the case of Italian bees, being hastened by extremely hot weather.

In nature there is a marked slowing down in work of the colony after the queen cells have been started preparatory to swarming, espe-

cially during the last few days previous to the issuing of the swarm, when the field workers in increasing numbers remain in the hive instead of working in the fields. In some cases in nature the instinct to gather nectar is almost entirely subordinated for several days at this time, the swarming instinct apparently becoming dominant. In well-managed colonies this is not universally true.

When the swarm issues, a varying proportion of the adult bees, together with the old queen, fly from the hive, leaving in the original hive a greatly reduced number of adult worker bees, a



FIG. 1.—Swarm clustered.

large number of unemerged young bees, and several unemerged young queens. Some of the drones accompany the swarm, but many of them remain in the hive. After circling in the air the swarming bees form a dense cluster (fig. 1) on some convenient support, and after an interval they break the cluster and fly to a chosen abode for the inauguration of a new colony. After establishing themselves in a new home the bees begin almost immediately to build comb, the queen begins to lay eggs, and three weeks later young bees begin to emerge from the cells.

About a week after the issuing of the prime swarm the first of the young queens in the parent colony emerges from her cell. Instead of destroying the other young queens and establishing this first emerged young queen as the new mother of the colony, the bees usually swarm again about eight days after the prime swarm has issued, this after-swarm being accompanied by one or more young queens. Other afterswarms, each one smaller than the preceding, may issue with an interval of one or two days between until the colony is so reduced in numbers that further swarming is given up and all but one of the remaining young queens are killed. About 10 days after emergence the surviving young queen usually begins to lay, and normal brood-rearing is again established in the parent colony after an interval of at least 16 days during which no eggs have been laid. Each after-swarm establishes itself in a new abode, begins building its combs, and the young queen begins to lay about 10 days after emergence. If sufficient food is available such colonies may build up to normal strength for winter. This is the natural method of reproduction of colonies in the honeybee.

OBJECT OF SWARM CONTROL.

Swarm control is one of the most important factors in the recent development of commercial honey production on an extensive scale. It was practically unknown until within comparatively recent years. Formerly a colony swarmed when it got ready, and no attempt was made to foretell, forestall, or prevent the act. It was necessary to watch the bees constantly during the greater part of the day while the swarming season lasted to prevent the escape of issuing swarms. When a swarm issued it was hived in a separate hive, and in due time the parent colony sent out one, two, and often three or more after-swarms, thus dividing the original colony into several parts, each of which was too small for profitable honey production, except during an occasional season of abundance or in an especially favorable locality. The issuing of these prime swarms and afterswarms was looked upon as a part of the annual program of the bees.

Gradually methods were devised for the prevention of afterswarms, and systems of management were worked out whereby the actual working force of the colony is not divided by the issuing of the prime swarm. During more recent years methods have been devised by which swarming is either prevented entirely or the act of swarming is anticipated by the beekeeper, which permits the control of swarming without constant attendance. This has made it possible for a beekeeper to operate a series of apiaries without an attendant in each to watch for and hive the issuing swarms.

The beekeeper's problem at the beginning of the honey-flow is twofold: First, to prevent a division of the working force of the colonies; second, to stimulate the storing instinct to the utmost degree throughout the honey-flow. A division of the working forces or a subordination of the storing instinct at this time will cause a loss in the crop. Swarming can be prevented in many ways, but great care is necessary to avoid causing a subordination of the storing instinct, thus reducing the crop of honey, because the bees work with less vigor.

In extracted honey production it is now possible practically to prevent swarming in certain regions where the character of the honey-flow, its duration, and the time of its occurrence with reference to the advancement of the season are such as to discourage swarming, but this is by no means true for all regions. In comb-honey production it is possible greatly to reduce swarming by modern swarm preventive measures, but under some conditions in certain localities there are seasons when swarm control is still, as in the past, one of the greatest problems of the comb-honey producer.

FACTORS INFLUENCING THE TENDENCY TO SWARM.

Swarming is a fundamental instinct in the honeybee and can not be easily eliminated. Just what it is that brings uppermost the swarming instinct when conditions are favorable is not positively known, but it is well known that certain factors contribute to the tendency to swarm, and if care is taken to prevent their development in the colony this tendency is greatly reduced.

Colonies in the same apiary during the same season do not all behave alike as to swarming. Usually some colonies make no effort to swarm even during seasons when swarming is general; other colonies yield readily to ordinary preventive measures, while still others are so determined to swarm that gathering and storing are to a large extent subordinated until swarming is past. This variation may be partly due to a difference in hereditary characteristics and partly to a difference in the hives and the combs; but when these are nearly uniform throughout an apiary there is still a great variation in the tendency to swarm due to a difference in the distribution of the bees within the hive, a congestion of bees within the brood-nest being highly conducive to swarming while a distribution of the bees to parts of the hive other than the brood-nest, so that only enough bees are left there to care for the brood, usually results in no swarming. When young bees are emerging daily in great numbers, as during the spring brood-rearing period, they become the chief offenders in producing a congested condition within the brood-nest, on account of their habit of remaining on the brood-

combs for some time after emergence before going to other parts of the hive or to the field.

In some cases failing queens may be superseded during the swarming season, and swarming may result from the presence of queen-cells begun in response to the superseding impulse. Throughout this discussion of the factors which influence the tendency to swarm only normal swarming is included. Swarming through superseding of queens, after-swarming, and swarming out because of hunger or advanced stages of brood disease have factors in the cause which do not apply to ordinary swarming.

INFLUENCE OF HEREDITY.

The variation as to swarming in different races of bees, and even within the race, has suggested the possibility of producing a non-swarming strain of bees. Considerable effort has been expended in this direction by breeding only from those colonies which show the least disposition to swarm, on the theory that the swarming instinct can be bred out. It is not possible to measure accurately the progress that has been made in this direction, largely because the breeder, during years of careful selection in breeding, may at the same time have modified his methods unconsciously, so that the bees swarm less because of better management. Considerable progress may have been made in reducing swarming by the elimination of undesirable stock, and it certainly is advisable to select as a breeding queen one whose colony shows little tendency to swarm, other factors being equal. It is a good rule to replace the queen of every colony that persists in swarming without sufficient cause by a young queen reared from the best breeding queen available. There is, however, no reason to expect that swarming will ever be eliminated by breeding alone.

INFLUENCE OF THE HIVE AND COMBS.

Some of the variation among colonies in the tendency to swarm is due to a difference in the hives and the combs. The size and shape of the brood-chamber, the character and arrangement of the combs, the facility with which the bees can ventilate every part of the brood-chamber and supers, and the ability of the bees to control the temperature of the air within the hive during hot weather are important factors which influence the tendency to swarm. Various hives, therefore, have been devised with the view of eliminating swarming.

SIZE OF THE BROOD-CHAMBER.

Usually there is more swarming from hives that have small brood-chambers than from those that have large brood-chambers. Under favorable conditions a good queen will increase the number of eggs which she lays in the spring, as the number of workers to take care of the resulting brood increases, until 70,000 or more cells may be occu-

pied with brood at one time. If the room for brood-rearing is all occupied at any time before the maximum is reached, the colony may prepare to swarm, providing other conditions are favorable. To prevent swarming from this cause, therefore, it is necessary either to use a brood-chamber containing sufficient room for the spring brood-rearing or to give an additional brood-chamber during the spring if a small hive is used. So far as swarming is concerned, it is necessary to have a large brood-chamber only during the short period when brood-rearing is heaviest. Large hives, however, do not of themselves entirely prevent swarming.

CHARACTER OF THE BROOD-COMBS.

The combs of the brood-nest should be suitable for the rearing of worker brood throughout except for a few cells of drone-comb in the lower corners of some of the frames, which can not be entirely eliminated. It is quite possible to have a brood-chamber of ample size for the maximum amount of brood, but at the same time to have the brood-rearing space so reduced by imperfect combs that, so far as swarming is concerned, the effect is the same as if the brood-chamber were much smaller. Imperfect cells and drone-comb within the brood-chamber not only reduce its capacity for worker-brood but such imperfect comb may act as an obstruction to the queen in expanding the brood-nest in the spring. If combs unsuitable for brood-rearing are between the combs already occupied with brood and the perfect combs beyond, the imperfect comb stands in the way of a free expansion of the brood-nest, the queen may confine her work to but one side of the hive at a time, and swarming may follow. When two stories are used early in the season to supply the necessary brood-rearing space, it is important that combs which have perfect worker-cells to the top bar be used at least in the lower hive body to permit the queen to work readily through both stories. When combs having several rows of imperfect cells next to the top bar are used, the queen may be partially confined to one or the other of the hive bodies because of the space which intervenes between the available worker-comb in the two hive bodies. The partial confinement of the queen to one or the other of the two brood-chambers in this way may be equivalent to the use of but one brood-chamber, so far as available room for the queen is concerned.

As a swarm-preventive measure it is important, therefore, that all the combs used in the brood-chamber be suitable for the rearing of worker-brood throughout practically their entire area. Such combs can be provided only by the use of full sheets of foundation in the brood frames, together with special care in wiring the frames, im-

bedding the foundation, and having the combs built under favorable conditions. In extracted honey production much can be done to improve the character of the combs used in the brood-chamber by sorting out all imperfect ones for use only in the supers. Some beekeepers use special methods of wiring the frames by which the stretching of cells in the upper portion of the combs may be largely overcome. If brood is extended in new combs to the top bar of the frames during the first season, the combs are so strengthened by the cocoons that there is less tendency for them to stretch subsequently and cause misshapen cells in the upper portion.

Good combs so arranged that the brood-nest may be expanded without interruption until the maximum of the spring brood-rearing has been reached go a long way toward the prevention of swarming. Nevertheless, for reasons given later, these do not of themselves insure that there will be no swarming.

SPACE WITHIN THE HIVE.

Space that is not occupied by comb, especially within the brood-chamber, may influence the tendency to swarm. A deep space between the bottoms of the frames and the floor of the hive is undoubtedly advantageous in hot weather. This space may be as much as seven-eighths inch, with little or no trouble from the bees building comb below the frames unless they are badly crowded for room. Some beekeepers use a space 2 inches deep or more, but put under the frames a slatted rack to prevent the bees building comb there. This affords a large amount of room for the field bees during the night and also provides abundant opportunity for ventilation during the heat of the day.

Some extra space can be provided within the brood-chamber by spacing the brood frames farther apart. The bees will increase the thickness of that portion of the combs which contains honey, but they do not increase the thickness of that portion which contains brood, and the spaces between the combs are accordingly wider within the brood area. If the frames are spaced too far apart, however, the bees may build a thin comb between. Combs are usually spaced from $1\frac{3}{8}$ to $1\frac{1}{2}$ inches from center to center. The principle of wider spacing of brood-combs has been utilized in the construction of a nonswarming hive in which the combs are separated about an inch and slatted frames are inserted between the combs to prevent the bees from building in this space, but such hives have not come into general use.

VENTILATION.

Large entrances reduce the tendency to swarm by adding to the comfort of the bees during hot weather. Bees need much more

ventilation during the honey-flow, when they are more active than at other times. It is sometimes advantageous to push one of the supers or the cover forward or backward on the hive far enough to make an opening for additional ventilation. Some beekeepers bore a hole an inch or more in diameter in one end of each super. These holes can be closed easily with a metal slide or a cork when not needed. It is usually not advisable to attempt to give ventilation in or between comb-honey supers because the bees are slow to seal honey adjacent to such openings, but ventilation may be given between the first comb-honey super and the brood-chamber by sliding the lower

super forward far enough to form an opening for ventilation at the back.

The location of the apiary should be such that there is a good circulation of air throughout the yard. Apiaries are sometimes located in hot nooks, where there is little circulation of air, and this usually results in an abnormal tendency to swarm.

SHADE.

Protection of the hives and supers from the direct rays of the sun during the hottest part of the day should decrease the tendency to swarm. Covers made of a single thickness of lumber, if unprotected, may cause great discomfort to the bees and may compel them to leave the supers during the heat of the day, which is a

condition favorable to swarming. To prevent this, shade-boards large enough to project beyond the edges of the hive (fig. 2) may be used over the covers. These should be adjusted with one edge even with the north side of the hive so that the extra width projects on the south side, and there should be a space between the hive cover and the shade board to permit a circulation of air. The double covers which have an air space between the inner and outer parts afford more protection from the sun's rays than do single covers, but these do not shade the sides of the supers.



FIG. 2.—Shade-board projecting beyond the hive on south side.

The hives, supers, and covers should be painted white, because the white surface better reflects the sun's rays. If no shade-board is used the covers should be repainted frequently. Other things being equal, it is to be expected that the tendency to swarm will be greater when dark or weather-beaten hive covers are used than when newly painted white covers are utilized, unless shade-boards are used over them.

The beekeeper who is much troubled with swarming can not afford to neglect the character and the arrangement of the combs, the size, shape, and construction of the hives, or even the color of the hives, if he desires to prevent swarming to the fullest extent, though the total prevention of swarming can not be expected from the character of the hives and combs alone.

INFLUENCE OF LOCALITY AND SEASON.

During some seasons few, if any, colonies attempt to swarm, while during other seasons and under similar management a majority of the colonies may prepare to swarm, especially if comb-honey is being produced. Generally speaking, bees are expected to swarm less during seasons of meager supply of nectar, whereas many swarms are expected in seasons of plenty; yet bees often swarm freely when nectar is not abundant and but little when it is abundant. The tendency to swarm, therefore, is not necessarily directly connected with the quantity of nectar available during the swarming season if a sufficient supply of food has been available previously to enable the colony to build up to swarming strength.

Furthermore, in some regions swarming may be troublesome during most seasons, even after years of careful selection in breeding, together with the best of equipment and management, while in other regions bees of almost any strain, when ordinary precautions as to equipment and management are taken, are practically nonswarming year after year. Why do bees swarm freely one season and refrain from swarming the next, if both seasons are prosperous, and why do bees in one region habitually swarm excessively, while bees of the same strain, in the same kind of hives, and under similar management, but in another region equally good, swarm little, if any? The answers to these questions are apparently closely connected with the rapidity with which the bees build up in the spring, together with the character of the honey-flow and the weather conditions during the swarming season.

INFLUENCE OF CHARACTER OF SPRING BROOD-REARING.

Throughout the entire country there is a definite period during fall and winter when brood-rearing is entirely suspended in all normal colonies. When brood-rearing begins again in the spring, if sufficient

food is available, the amount of brood is usually increased until a certain maximum is reached, after which brood-rearing declines. When spring brood-rearing is most extensive the queen may lay more than 3,000 eggs daily, but she does this during a short time only. There is, therefore, a well-marked period of extensive brood-rearing in the spring. Apparently this spring expansion of brood-rearing is stimulated by the oncoming of spring following the period of little or no brood-rearing. It is stimulated also by early incoming pollen and nectar, but may occur even when these are lacking, provided a sufficient quantity of honey and pollen is stored in the hives and water is available. In this respect the spring period of extensive brood-rearing differs greatly from other periods of more or less extensive brood-rearing, since after the first great expansion in brood-rearing the presence of honey stored in the hive is not a sufficient stimulus to cause the bees to rear brood extensively.

In all regions swarming may be expected within a well-defined "swarming season" which coincides roughly with the period of maximum brood-rearing. When there is a well-marked secondary expansion in brood-rearing later in the season it may be accompanied by a secondary swarming season. When the primary period of maximum brood-rearing is prevented because of extreme weakness of the colony, or a dearth of food, swarming may simply be postponed until a later honey-flow and may then be expected as during the normal swarming season. If no period of extensive brood-rearing takes place during the season there is usually no swarming. Differences in seasons and differences in localities may modify the rapidity with which brood-rearing is carried on, so that the maximum amount of brood may be greater in certain years than in others and greater in certain localities than in others.

Other things being equal, the tendency to swarm is the greatest in those localities in which, on account of climatic conditions and available food, the bees increase brood-rearing most rapidly in the spring. In any locality the tendency to swarm is greatest during those years when, because of favorable conditions, the bees build up in the shortest interval in the spring. Among the colonies in the apiary the tendency to swarm is greatest in those colonies which reach their peak of brood-rearing most rapidly. When colonies of bees build up so rapidly in the spring that a maximum of 60,000 to 70,000 cells of brood is reached, they have during a certain period a large proportion of recently emerged and emerging bees. Such colonies are in the best possible condition to gather and store a crop of honey if the honey-flow begins at about the time they reach their maximum in brood-rearing, but they are strongly inclined to swarm.

When brood-rearing is conducted moderately, colonies may have as many workers when they reach their maximum strength, but they

do not have as large a proportion of young bees at any time as those which build up more rapidly. Thus, two colonies at the beginning of the honey-flow may be equally strong as to the number of bees but differ decidedly as to the average age of the bees and, other things being equal, the tendency to swarm is greater in the colony having the larger proportion of recently emerged and emerging bees.

INFLUENCE OF YOUNG BEES.

The fact that the tendency to swarm is greatest at about the time the bees are rearing the greatest amount of brood has led to the belief that swarming is caused by the presence in the hive of a large proportion of young bees not yet old enough for field work. The measures in common use for the prevention of swarming tend to obviate this predominance of young bees or to relieve the crowded condition resulting from their presence within the brood-nest, and the successful remedies for swarming are those which correct this unbalanced condition in the population of the colony. Natural swarming itself removes the excess of young bees and brings about a condition in which none of the workers need be unemployed if there is a honey-flow. It is probable that the bees too young to work in the fields contribute to the tendency to swarm by their persistence in remaining for several days within the brood-nest near where they emerged from the cells, instead of going to the more remote and less congested parts of the hive, and in this way they produce a crowded condition within the brood-nest.

The sensation of strength in the colony is evidently not in proportion to the number of bees within the hive but depends largely upon their distribution. Even weak colonies may become crowded and swarm if most of the bees of the colony confine themselves to the small area occupied by brood, because this area is surrounded by sealed honey or imperfect combs, or because the more remote portions of the hive are so unattractive that the colony does not expand its activities beyond the brood area in proportion to the increasing numbers of oncoming young bees. On the other hand, a strong colony which rapidly expands its work into remote parts of the hive may apparently entirely escape the sensation of great strength because of the better distribution of the bees.

The distribution of the young workers during the first two weeks of their lives when they are emerging at the rate of 3,000 or more per day undoubtedly has much to do with the tendency to swarm. It is, therefore, highly important that those parts of the hive outside of the brood area be attractive and easily available for the oncoming young bees, so that they will expand into and occupy the more remote portions of the hive instead of crowding the brood-nest.

INFLUENCE OF HONEY-FLOW.

A colony of bees that is approaching its maximum of strength at the beginning of or during the honey-flow, having many young bees recently emerged, may be able to send but a comparatively small number of workers to the field because most of them are too young for field work. In this case the brood-nest is crowded with these unemployed young bees during the heat of the day, and the added prosperity of the honey-flow may quickly bring on the swarming tendency. On the other hand, a colony that has passed its maximum of brood-rearing some time previous to the honey-flow, having comparatively few emerging and recently emerged young bees, but most of its workers old enough to work in the fields, may send such a large proportion of its workers to the fields when the honey-flow begins that most of the workers are out of the hive during the heat of the day and swarming may be given up. The advent of the honey-flow, therefore, may have an opposite effect as to swarming upon colonies which are equally strong in number of bees but different as to the age of the workers. This may explain the variation observed in various regions as to the effect of the honey-flow on swarming.

INFLUENCE OF WORK IN SUPERS.

The giving of additional room and employment to attract the unemployed bees out of the brood-chamber is of great importance in the expansion of the activities of the colonies and has a direct bearing upon an advantageous distribution of bees throughout the more remote portions of the hive.

Usually the tendency to swarm is stronger during the early part of the honey-flow if the colonies are strong in young bees at that time. It is important, therefore, that each colony expand into and occupy promptly the first super that is given. To accomplish this it is necessary that this first super be attractive to the young hive workers. If supers, either for comb-honey or for extracted-honey, containing only foundation, be given to a strong colony just before the honey-flow the bees will not take possession of them and begin work on the foundation to any extent until the honey-flow has begun, and meanwhile the colony is crowded for room. The addition of this room with only foundation, therefore, does not affect the distribution of the bees until they take possession of and occupy the super, while in the meantime conditions for swarming may develop rapidly. On the other hand, if a super of empty combs be given to a strong colony previous to the honey-flow, the younger bees in great numbers immediately take possession of the added super and begin to repair the comb and to prepare it for use. If the colony is strong these bees do not merely explore the super but

actually occupy it, the brood-chamber, therefore, being relieved of many thousand young bees that are not yet old enough for field work.

In either comb-honey production or extracted-honey production, if the colonies are not strong when the first super is given they may refuse to expand into and occupy it or they may take possession of only a small portion of it. Such colonies usually store any honey they may accumulate at this time in the combs of the brood-chamber adjacent to the brood, and if in this way they surround themselves with honey and seal it they are not inclined to pass this finished work readily to expand into the supers beyond. In this way they may block off and occupy only a small portion of their hive and crowd this limited area even though empty combs are used in the supers above, whereas strong colonies readily expand beyond such barriers. For this reason it is sometimes more difficult to prevent swarming in colonies of medium strength than in strong ones. Any barrier of any kind between the brood-nest and the supers becomes especially objectionable in colonies of deficient strength. Some strains of bees are more inclined to limit their activities to a portion of the hive in this way than other strains, and may be more inclined to swarm for this reason.

The first super usually should be given before the bees need it, and especially in extracted-honey production it should be given as soon as the bees are strong enough to occupy it, in order to furnish a place outside of the brood-nest for the multitude of oncoming young bees. This first super for extracted-honey production should be supplied with empty combs, or at least half of its frames should contain empty combs. If no empty combs are available for this purpose, some of the combs of brood should be put into the super to start work there promptly and distribute the bees over greater surface. The first comb-honey supers are usually put on a little later than supers for extracted honey and should contain some sections in which the combs are already built, which were saved from the previous year. These combs usually induce the bees to occupy the super earlier than when only foundation is used in the sections.

As work progresses in the first super and the cells are being built out to full length, the room that can be occupied by bees decreases, making it necessary, if the super has been completely occupied, for some of the bees to go elsewhere. When the honey is finally ripened and sealed, few bees remain in the supers. Therefore, if a second super is not given until the first one is finished, most of the super workers are forced to go back into the brood-chamber. In the meantime there is no place for the oncoming young bees to take up inside work before they are old enough to begin to work in the fields. The super workers, forced out of the super back into the brood-chamber.

added to those emerging rapidly in the brood-chamber, give a large number of bees there which must remain unemployed until they are old enough for field work, thus causing a condition highly conducive to swarming. There is, therefore, a critical period not only just before the bees take possession of the first super of the season, but to a certain extent just previous to the giving of each additional super.

During the early part of the honey-flow when swarming is imminent additional supers should be supplied as the bees need them, before any of the workers are crowded back to the brood-chamber. If the honey-flow is good, the additional supers should be given as fast as the bees can be induced to occupy them, in order that the expansion of the work and the room in the supers shall keep pace with the oncoming of the young workers. Each newly added super should be so accessible, comfortable, attractive, and advantageously placed that young bees will come up and occupy it at once, which they may fail to do if newly added supers are too hot, too cold, too remote, difficult to ventilate, or otherwise unattractive. Supers should be snug and warm during cool weather and protected from too much heat during hot weather. During the latter part of the honey-flow, as the swarming season begins to wane, the bees may be crowded as to super room to induce them to finish the work well and concentrate the honey in fewer supers, but by this time there is less danger of swarming.

SPACE FOR THE EVAPORATION OF NECTAR.

Super room should be adequate not only for the storage of ripened honey but also for the distribution of the thin incoming nectar throughout a large surface of comb with but a small amount in each cell, to facilitate the evaporation of water from the nectar. A large amount of comb surface is needed for this purpose in regions where the nectar is especially thin when it is first brought in. In arid climates not so much extra room is needed for the evaporation of nectar as in humid climates. When all the cells available for ripening nectar are in use during a heavy honey-flow a slowing down of the work of the colony must follow, for the bees will not fill the cells full of raw nectar. When nectar is thin and abundant, the evaporating space may all be in use before much honey has actually been stored, which may result in a stagnation of the work of the colony. and in turn may increase the tendency to swarm. For this reason it is usually necessary to give more supers during the honey-flow than are actually filled with ripened honey.

TIERING UP SUPERS.

In producing comb-honey if the honey-flow is good and swarming is imminent each newly added super may be placed immediately

above the brood-chamber; that is, between the brood-chamber and the supers in which work has already been started. This induces the bees to begin new work promptly and takes additional thousands of young bees out of the brood-chamber into the supers. (See Farmers' Bulletin 1039.) In extracted-honey production when empty combs are used in the supers it is not so essential to place the newly added ones below those already on the hive, but to do so undoubtedly entices more bees out of the brood-chamber than when they are placed on top of the other supers. Shallow extracting supers are usually tiered up in the same manner as comb-honey supers, each newly added one being placed below the supers already on the hive during the time that swarming is imminent. If full-depth extracting supers are used, half of the combs may be removed from the middle of the partly filled super and empty combs or frames of foundation taken from the new super may be put in their place. The partly filled combs that were removed are then placed in the middle of the new super, after which it is placed on top. This process may be repeated if necessary as often as it is desirable to give additional room close to the brood-chamber.

Great care should be taken, especially in comb-honey production, to discontinue such a rapid expansion of super room in time to have the work well finished. During the latter part of the honey-flow empty supers may be added on top of those already on the hive in either comb-honey or extracted-honey production, to prevent too much incomplete work at the end of the honey-flow, for at this time there is less probability of swarming than earlier in the season.

In regions where the swarming season occurs during the honey-flow it is of great importance that every condition possible be provided that will entice the younger bees from the brood-chamber into the supers and the field bees from the brood-chamber to the fields. If the brood-nests can thus be kept free from too many unemployed bees during the swarming season there should be little inclination to swarm.

INFLUENCE OF IDLE FIELD BEES.

The brood-chamber may be congested with bees, however, and swarming may sometimes occur apparently through no fault in the distribution of young bees within the hive, since a crowded condition may be brought about or intensified by the field bees as a result of certain peculiarities of weather conditions and honey-flow.

The presence of a large number of field bees within the hive during the swarming season evidently greatly increases the tendency to swarm. When the field bees are out of the hive the colony is relieved of their presence during the heat of the day when they would add

most to its sensation of strength. If, however, because of some fault in the management, because of adverse weather conditions, or because the flowers yield nectar erratically, the field bees remain in the hive, they add greatly to the crowded condition of the brood-nest and, therefore, increase the tendency to swarm.

It is well known that the advent of a honey-flow and active work in the field greatly stimulates the activities of the bees within the hive. Thousands of younger bees or hive workers now begin the tasks of preparing empty combs for incoming nectar, or for brood-rearing, building new comb, transferring nectar or honey, and ripening the new nectar, but there is apparently a rather delicate balance between the work inside the hive and the work in the field, for if the work inside the hive is interrupted in any way the work of the field bees slows down accordingly. Therefore those factors already discussed which tend to produce congestion and idleness among the young workers within the brood-nest during a honey-flow quickly add greatly to the number of unemployed bees by causing the field bees to remain in the hive instead of going to the fields.

If for any reason the expansion of the activity of the hive workers is interrupted a stagnation of the activity within the hive must follow, which in turn causes more and more stagnation in the field work. Such a condition may arise if the young bees do not readily enter and occupy the first super that is given, if additional room is not given promptly to keep pace with the increasing number of oncoming young bees, if all the available space for evaporating nectar is in use, if the hive workers are driven out of the supers into the brood-chamber by heat or lack of ventilation, if the newly added supers are too remote or otherwise unattractive, or if so much of the work is being finished that the new and unfinished work is less than that needed to employ most of the hive workers. When the field workers stay within the hive in increasing numbers during a honey-flow, preparation for swarming is the usual result. In this way a slight interference with the activities of the hive workers may quickly develop into a serious condition which might easily have been avoided if taken in time.

When the field bees are confined to their hives by several days of rain just previous to or during the swarming season, the result may be a greatly increased tendency to swarm. Sometimes two weeks of rain at about the time of the normal swarming season is followed by intense swarming. When the field bees remain in their hives a part of the time during the honey-flow because the flowers yield nectar erratically the tendency to swarm may be greatly increased. The presence of the great mass of field bees within the hive during the heat of the day from any of these causes must add greatly

to the tendency to swarm, especially when the bees crowd in great masses in the space below the frames and in the lower portion of the brood-chamber, as they usually do when they are in their hives temporarily during the honey-flow.

In extracted-honey production it is not difficult by good management to prevent a crowding of the brood-nest during the honey-flow by either young bees or field bees, except in the last two cases mentioned. Both of these conditions are frequently encountered, especially in the northeastern portion of the United States in the clover region. There is, of course, no way by which the field bees can be prevented from staying in their hives in either case, even if it were desirable to do so, but by providing a deep space below the frames and an abundance of ventilation, together with adequate protection from the direct rays of the sun, the discomfort of the colony brought about by the field bees within the hive during the day may be considerably relieved.

To prevent swarming to the greatest extent it is necessary to induce most of the hive workers to leave the brood-nest early in their lives to take up work in the supers, so that the bees of the hive are distributed over a large comb surface which in turn should stimulate the field bees to go to the field in greater numbers. During the heat of the day no more bees should remain within the brood-chamber than are needed for the work to be done there. Such a distribution and employment of the hive workers usually induces the field workers to put forth the greatest energy in gathering nectar.

NATURAL SWARMING.

After having used all the known preventive measures, there will still be some colonies that attempt to swarm in certain locations during some seasons even in extracted-honey production, and in comb-honey production a large percentage of colonies may attempt to swarm. In either case, but especially in extracted-honey production, some of these swarms are probably a result of the imperfect application of preventive measures in time to prevent the beginning of the series of events which lead up to the actual issuing of the swarm. Except in certain localities, the beekeeper whose equipment and management meet the requirements previously outlined in this bulletin as swarm preventive measures should be troubled little by swarming if extracted honey is being produced.

CORRECTION OF CONGESTION BY SWARMING.

The conditions within the brood-chamber are changed greatly by swarming, both in the swarm and in the parent colony. In the swarm there are no very young bees and, of course, no emerging

bees during the first three weeks. The workers of the swarm that are not needed for the work inside the new hive are old enough for work in the fields, and when most of the bees of a colony can go to the fields for nectar during the heat of the day a surprisingly large number may be massed together in one hive without causing a stagnation of their activities. When the first young bees begin to emerge three weeks later the daily emergence of young is small in comparison with that of a colony during the spring brood-rearing period; therefore the swarms usually do not become greatly congested with young bees again during the same season. Swarms that are hived in an empty hive on a new location seldom swarm again the same season, especially where the season is short, but if they are hived on empty combs or combs containing honey or a little emerging brood they may do so. Even when most of the workers of both the parent colony and the swarm are reunited, or when two or more swarms are hived together in one hive, the bees are usually satisfied without further swarming if plenty of room is given in the supers.

The parent colony loses most of its field workers and the queen when a swarm issues, but it has a large amount of brood and several queen-cells usually sealed or nearly ready to be sealed at the time of the issuing of the swarm. When the young queens begin to emerge about a week later, if the beekeeper does not interfere, the colony may cast one or more after-swarms, each accompanied by one or more of the recently emerged virgin queens. When there are no longer sufficient bees left to divide up among the emerging queens, all but one of the young queens are killed, this surviving one in the normal course of events later becoming established as the new mother of the parent colony. The rapid emergence of young bees soon restores the parent colony to good strength, but when swarming takes place during the honey-flow the parent colony may not recover sufficient strength in field workers to take an important part in gathering the season's crop of honey. After the young queen becomes established a parent colony seldom swarms again the same season, even though it may become quite populous and the season may be prosperous.

Thus neither the swarm having the old queen and the older bees in establishing itself in a new home, nor the parent colony having the young queen in reestablishing itself in the old home, is inclined to swarm again the same season. In each case there is an interruption in the emergence of young bees. These are important facts in the control of swarming.

INFLUENCE OF YOUNG QUEENS.

The fact that parent colonies seldom swarm again the same season has led to the belief that colonies having young queens do not swarm the first summer of the queen's life, but while such colonies are less

inclined to swarm the use of young queens can not be depended upon except under certain conditions. If a young queen is introduced into a colony previous to the swarming season after a period of queenlessness, so that there is a period of 10 days during which no eggs are laid, there is usually no attempt to swarm again during the same season, especially if this interval of no egg-laying occurs late enough so that the young queen is not able to reach her maximum of egg-laying before the close of the honey-flow. If, however, the old queen is removed from a colony previous to the swarming season and a young laying queen is introduced at once without an interval of no egg-laying, the tendency to swarm may be reduced little, if any. The condition of the colony brought about by a period of queenlessness is apparently a greater factor in reducing the tendency to swarm than the age of the queen, for if the old queen is removed or caged within the hive for 10 days and then reintroduced, no queencells being permitted to mature in the meantime, the bees give up swarming frequently for the remainder of the season. Colonies which have both a young queen and the interval of queenlessness usually may be considered safe from swarming again the same season, especially in the North. Such colonies are comparable to the parent colony in nature.

VARIATION IN TIME OF SWARMING SEASON IN RELATION TO THE HONEY-FLOW.

Since the time of the swarming season is apparently determined largely by the great expansion of spring brood-rearing, it does not necessarily coincide with the main honey-flow of the season, although the honey-flow may greatly modify the tendency to swarm (p. 14). The time of the swarming season with reference to the time of the main honey-flow is a factor of importance in choosing the proper management of colonies that swarm or prepare to swarm.

(1) In some localities, particularly in some of the Southern States, the main honey-flow may not occur until six or eight weeks after the swarming season. The colonies may reach their maximum strength during the spring brood-rearing period and swarming may be stimulated by a light honey-flow. There may be considerable swarming even when the colonies are securing no more than a living from the fields, and sometimes bees may swarm even when it is necessary to feed the newly hived swarms to prevent starvation. If there is a complete dearth of nectar at this time, however, the bees usually give up swarming and greatly reduce their brood-rearing activities. Such colonies after having reached their maximum strength in the spring are not inclined to rear brood extensively again until the honey-flow begins. Under these conditions the colonies arrive at the beginning of the honey-flow with a large proportion of old bees and usually do

not swarm during the honey-flow unless it is of sufficient duration for the bees to fill their hives again with brood and to become crowded with young bees before its close. Swarming is not difficult to control under these circumstances unless the bees are gathering a little more than a living at the time of the swarming season, and usually the addition of an abundance of room in the form of empty combs with the brood extending through two or more stories of the hive will practically prevent swarming under these conditions.

When swarming occurs six weeks or more previous to the beginning of the main honey-flow, both the parent colony and the swarm should be given every advantage to enable them to build up again to full strength, so that both may gather a full crop. In such a locality, if natural swarming is permitted, all afterswarming should be prevented (p. 25). It is better, however, to divide the colonies, some time before they have reached their maximum in spring brood-rearing, into two parts, supplying the queenless portion with a young queen, thus postponing the maximum egg-laying on the part of the old queen until later. This division prevents swarming during the normal swarming season, and, if adequate stores are supplied, should result later in two colonies in splendid condition for the honey-flow. Colonies should not be divided previous to the honey-flow, however, unless this can be done at least five or six weeks before the beginning of the main honey-flow, for this much time is needed for them to build up to full strength.

Another plan for controlling swarming so long previous to the main honey-flow is that of keeping the colonies below swarming strength by removing some of the bees, to be sold as package bees, where the beekeeper is so located that he can sell them profitably and does not desire to make further increase.

Some beekeepers who are located where the honey-flow occurs some time after the swarming season are able to move their colonies to other locations which furnish a honey-flow at this time, thus bringing the honey-flow and the swarming season together.

(2) When the honey-flow occurs during the swarming season, as in the clover region of the Northern States, the tendency to swarm is usually strong, while the main honey-flow is usually short. Under these conditions the colonies should not be permitted to divide their working forces by swarming, but most of the bees should be massed during the honey-flow, either in the swarm or in the parent colony. In regions where the swarming season and the honey-flow coincide, swarming is more difficult to control, especially if the field bees are confined to their hives a part of the time during the day by showers or by erratic yielding of nectar (p. 18), and the greatest precaution as to preventive measures is necessary. Remedial measures applicable here are discussed later in this bulletin.

(3) When the main honey-flow of the season occurs previous to the time the bees are in condition to swarm, the full crop can not be harvested because the colonies must utilize the honey-flow for building up to full strength. This condition is found in many localities in which the main honey-flow occurs quite early, if the management is not directed toward the early development of the colonies. The obvious remedy for this condition is a change in the management which may enable the bees to become sufficiently strong in time for the honey-flow. (See *Farmers' Bulletins* Nos. 1012, 1014, and 1039.)

HIVING NATURAL SWARMS.

The beekeeper who is operating but one apiary and expects to be present during the swarming season usually prefers to take precautions to prevent swarming as much as practicable, then hive the swarms that issue, rather than to examine all the colonies each week to anticipate swarming. If out-apiaries are being operated, or if the beekeeper is away from home during the day, natural swarming should not be permitted.

When natural swarming is permitted, the work of hiving the swarms is easier if the queens' wings are clipped¹ previous to the swarming season. This does not prevent swarming but it does prevent the swarm from leaving and averts the necessity of taking swarms down from tall trees or other inaccessible places, since a clipped queen can not go with the swarm and the bees will return to the hive. If by chance another swarm having a queen that can fly happens to be out at the same time and unites with the queenless one, the swarm can not be expected to return. The best time to clip the wings of the queen is usually during some early honey-flow, like that from fruit bloom, before the colonies have become very popu-

¹ To find the queen, take out one or two of the outside combs from the side of the hive next to the operator. If the queen is not on these combs, set them aside in order that the remaining combs may be more readily examined. If robbers are troublesome these combs must be put into an empty hive or a light box that will hold two or three frames and kept covered while they are out of the hive. As each of the remaining combs is removed from the hive, glance quickly over the exposed side of the next comb in the hive to see if the queen is there. If she is not there, turn the comb just removed to examine the other side and proceed in this way until the queen is found. As the combs are examined they are placed back into the hive on the side nearest the operator in order to maintain an open space between the combs already examined and those yet to be examined. This work should be done rapidly and no more smoke should be used than is necessary for rapid work. If the bees are inclined to be nervous and run on the combs it is necessary to watch for the queen in the spaces between the lower edge of the comb and the bottom bar of the frames, and also on the bottom and sides of the hive, for if the queen becomes frightened she may run off of the combs into these spaces.

When the queen is found she may be picked up by taking hold of her wings with the thumb and forefinger of the right hand. She is then transferred to the left hand and held lightly either by the thorax or by her feet. The right hand is now free to pick up a pair of small sharp-pointed scissors and clip off the major portions of the wings on one side. The queen is now transferred back to the comb by taking hold of the remaining wing.

lous. In the production of extracted honey and when the best swarm-control measures are employed, the clipping of the queens' wings is unnecessary and the practice is becoming less common.

Swarms that issue during the honey-flow or just previous to the beginning of the honey-flow should not be placed in a new location separated from the parent colony, since to do so would divide the working force of the colony, but the parent colony should be moved a short distance to one side and the new hive for the swarm put in its place. In this way the field force is all given to the swarm which now becomes the producing colony.

The hive of the parent colony should be moved while the swarm is out, the new hive put in its place, and the partially filled supers trans-



FIG. 3.—While the swarm is out, the hive of the parent colony is turned away, the new hive put in its place, and the supers transferred to the new hive, which is now ready to receive the swarm.

ferred from the parent colony to the new hive, which is then ready to receive the swarm. The hive entrance of the parent colony should be turned away from its former position (fig. 3) in order that the swarm may be hived in the new hive without a part of the bees entering the hive of the parent colony. It is sometimes advisable

to cover the old hive with a cloth while the swarm is being hived if bees attempt to enter it.

If the queen's wings have not been clipped, the swarm after having clustered may be shaken into a basket or a light box, which may be attached to the end of a pole, if need be. They should then be dumped immediately in front of the prepared hive, which should be arranged so they will not crawl under it, but can readily enter (fig. 4). A wide board, a cloth, or a newspaper may be used for a bridge to the entrance. If the bees do not begin to enter the hive at once, some of those nearest the entrance may be pushed in with a brush or a large feather. If some start to run away from the entrance they may be gently brushed toward it. The bees should not be permitted to crawl up the sides of the hive and cluster outside, but all should be induced to enter.

If the queen's wings are clipped, the operator should be ready to watch for and catch the queen while the swarm is issuing. When the queen is found she should be placed in a wire-cloth cage and put on the shady side of the hive until the swarm returns. The swarm may return and enter the new hive without clustering, in which case the cage containing the queen may be thrust part way into the entrance of the new hive, but the queen should not be released among the returning bees until after many of them have entered the hive, because the bees may again take wing if the queen is released too soon. If the bees cluster where they are readily accessible, it may not be advisable to wait for them to return of their own accord, since other swarms may issue and several of them join the cluster. They may be handled in hiving the same as though their queen were with them. A wire-cloth cage large enough to be set over a hive



FIG. 4.—Swarm entering new hive.

(fig. 5) is sometimes useful if many swarms issue at one time, for one of these may be placed over any colony just starting to swarm to catch the swarm as it issues, thus preventing the confusion usually brought about when several swarms unite.

PREVENTION OF AFTERSWARMS AND DISPOSITION OF THE PARENT COLONY.

By this method of hiving swarms the bees are soon at work again with renewed energy in the same set of supers which a short time

previously they were so eagerly deserting. The field force has not been reduced, the returning field bees from the parent colony all entering the new hive, since it is located where the old one stood. Frequently such colonies store even more honey than colonies that do not attempt to swarm. As soon as the swarm is established in the new hive the entrance of the parent colony should be turned back toward its former position (fig. 6), and a day or two later it should again be turned, so that the two hives now stand side by side, having their entrances close together (fig. 7).

If extracted honey is being produced the parent colony and the swarm can be reunited a day or two later by first destroying all the

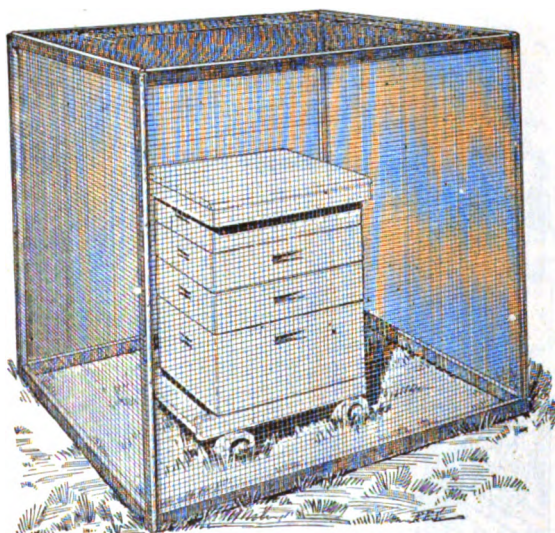


FIG. 5.—Cage arranged to catch issuing swarm. Especially useful when several swarms issue at about the same time.

queencells in the parent colony, then placing the hive body containing it (without bottom or cover) on top of the supers on the new swarm in the same manner as an additional super. In this way the parent colony and the swarm are in the same hive forming a single colony, the queen and the new brood-chamber being below the supers and separated from them by a queen excluder while the parent colony is

above the supers. Nine or ten days after the swarm has issued any queencells that the bees may have built in the parent colony during this interval should be destroyed. Under certain conditions, not yet fully explained, this has not been found necessary if the parent colony is separated from the swarm by at least two full-depth extracting supers, but with less than this distance between, such colonies may swarm when the young queens in the parent colony begin to emerge.

If increase is desired, this brood-chamber may be taken away a week after the swarm has issued, to form a new colony. In this case the queencells should not be destroyed. If too many bees cling to the old brood-chamber the bees from all but three or four of the combs may be shaken into the supers in order to strengthen the swarm

and also to make the parent colony too weak to cast an afterswarm. The combs containing the best queencells should not be shaken because of the danger of injuring the immature queens. If some combs having queencells are shaken the cells should be destroyed to prevent the emergence of any injured queens. If choice queencells from a breeding queen are available, all the cells on the combs from the parent colony should be destroyed and one of the choice cells should be given.

When comb-honey is being produced the parent colony can not well be united with the swarm directly in this way, but it should be left beside the swarm six or seven days, for on the eighth day the parent colony would normally cast its first afterswarm. It should then be moved away and given a new location well separated from other colonies in another

part of the apiary. This should be done when the young bees that have learned to fly during the week are flying freely, preferably early in the afternoon, and the hive should be carried away and placed on its new stand so carefully that the bees are not disturbed, in order that they will go to the fields without noting the change in their surroundings. If this is

done carefully, all of the field bees when returning from the field will return to their former location, where they must enter the other hive and unite with the swarm. This adds a large number of young workers to the swarm where they are of the greatest value at this time, and at the same time so reduces the number of bees in the parent colony that afterswarming is given up.

The successful prevention of afterswarming by this method depends upon the completeness of the reduction of the population of the parent colony just before the time for the issuing of the first afterswarm. If anything should prevent this reduction at the right time, such as confinement of the bees to the hive for a day or two by bad weather at the time the parent hive is moved away, or the emergence of the young queens earlier or later than expected, colonies treated in this way may have enough bees when the first young queen emerges to send out an afterswarm. Under such conditions

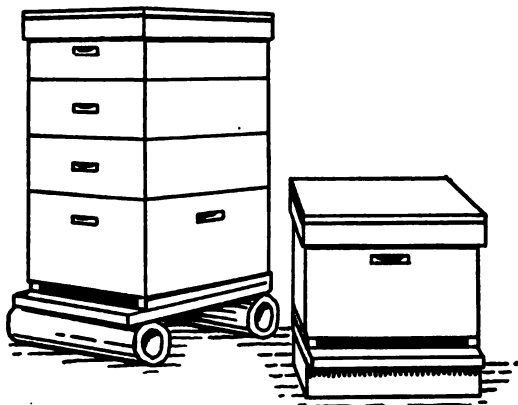


FIG. 6.—After the swarm has entered the new hive the hive of the parent colony is turned toward its former position.

it may be necessary to shake the bees from several of the combs of the parent colony, uniting them with the swarm at the time the hive is moved away, to be sure of a depletion of the parent colony sufficient to prevent afterswarming. Usually, however, this method can be depended upon without opening the hives to note the advancement of the queen cells or to shake out any of the bees.

If no increase is desired the parent colony may be moved to the opposite side of the swarm instead of to a more distant location, where it can be united with the swarm at the close of the honey-flow. In doing this it may be necessary to place the parent colony some distance beyond the swarm and turn its entrance away from that of the swarm temporarily to prevent the returning young bees finding their

hive as they may do if it is placed on the opposite side with its entrance close to that of the swarm.



FIG. 7.—A day or two later the hive of the parent colony is placed close to that of the swarm. Seven days later it is removed.

INTERRUPTION OF WORK IN SUPERS UNDESIRABLE.

When swarms are hived during the honey-flow in the manner described above, it is important that conditions within the new hive be such that the energy of the newly hived swarm is directed from the beginning chiefly to the work in the supers instead of

to work in the new brood-chamber. This is especially important during a short honey-flow, for the season may close before profitable work in the supers is resumed if the colony first fills the brood-chamber. Furthermore, a temporary cessation of work in the supers while the new brood-chamber is being filled may result later in a stagnation of the work of the colony brought about by a concentration of work in the brood-chamber. This applies particularly to comb-honey production, since in extracted-honey production there should be little if any interruption of the work in the supers after the swarm has been hived, unless the swarm is unusually small or unless the new brood-chamber is unusually large. The furniture used in the new brood-chamber, the size of the new brood-chamber, the number of bees in the swarm, the attractiveness of the supers (p. 14), and the character of the honey-flow all affect the continuity of the work in the supers when a swarm is hived.

INFLUENCE OF FURNITURE USED IN THE NEW HIVE

The brood-chamber in which a swarm is to be hived may be furnished with (1) frames that are empty except a narrow strip of foundation about an inch in width to guide the bees in comb building, (2) frames containing full sheets of foundation, (3) frames containing full sheets of foundation, together with one or more frames filled with comb, (4) combs of unsealed or mostly unsealed honey, (5) combs of emerging brood in which no eggs have been laid for at least 10 days (usually taken from a parent colony 10 days after the swarm issued, first having all queencells destroyed), and (6) empty combs. There is a great difference in the work in the supers after the swarm is hived, depending upon which of these is used. The least interruption in the work in the supers usually occurs when only narrow strips of foundation are used in the frames in the new brood-chamber, and the greatest interruption in the work in the supers usually occurs when a full set of empty combs is used. As to the degree of interruption of the work in the supers, the other combinations of furniture occupy an intermediate position between these two extremes, usually in the order named. When either narrow strips of foundation or full sheets of foundation are used in the frames in the new brood-chamber and the supers are transferred to the swarm at the time of hiving, there being no vacant cells in the new brood-chamber and comb building being in progress in the supers, the incoming nectar is taken to the supers. Under these conditions there is practically no interruption in the work in the supers, the work in the brood-chamber usually being carried on slowly for some time, especially if only narrow strips of foundation are used. In sharp contrast with this, if a full set of empty combs is used in the new brood-chamber when the swarm is hived, the work in the supers is usually neglected, the energy of the colony being directed chiefly to filling the brood-chamber with honey and brood, but after these combs have been filled such colonies usually work indifferently in comb-honey supers.

A single empty comb together with frames of foundation affords such a limited number of empty cells immediately available within the brood-chamber that its use does not tend to reduce the work in the supers materially and it affords storage space for incoming pollen which might otherwise be carried to the supers. The use of a single empty comb also greatly reduces the tendency to swarm out (p. 31). When combs of honey which are mostly unsealed are used, the bees may begin to transfer this honey into the supers almost immediately after being hived. When combs containing only sealed and emerging brood together with honey and pollen are used, there are so few vacant cells that these are usually prepared

to receive the eggs as the queen resumes egg-laying, so that most of the incoming nectar must be taken to the supers. As the remaining brood emerges the vacated cells are usually prepared for eggs until toward the close of the honey-flow.

The furniture used in the new brood-chamber also has an influence upon the tendency to swarm again the same season. When the bees build a set of new combs from narrow strips of foundation or full sheets of foundation they rarely swarm again, but when swarms are hived on combs of emerging brood, empty combs, or combs of honey, sometimes many of them may attempt to swarm again the same season if the honey-flow is of considerable duration. As to the effect upon this tendency, the various combinations of furniture for the new brood-chamber usually stand in the following order, increasing through the series: (1) Narrow strips of foundation, (2) full sheets of foundation, (3) full sheets of foundation together with one or more empty combs, (4) empty combs, (5) combs of honey, and (6) combs of emerging brood.

While narrow strips of foundation stand first, both as to forcing immediate work in the supers and as to reducing the tendency to swarm again the same season, their use is open to the serious objection that so much drone-comb is usually built that many of the combs built in this way are not suitable for subsequent use in the brood-chamber. Some comb-honey producers, however, use them, then at the close of the honey-flow unite the parent colony and the swarm, placing the brood-chamber of the parent colony above that of the swarm; then in the fall the lower brood-chamber may be removed and the now empty combs cut out to be rendered into wax. Many comb-honey producers prefer to use full sheets of foundation in all the frames or in all but one of the frames of the new brood-chamber for hiving swarms.

When either narrow strips of foundation or full sheets of foundation are used in the new brood-chamber, a queen excluder should be used when the supers are transferred from the parent colony to the swarm at the time of hiving, and precautions should be taken also against swarming out (p. 31).

CONTRACTION OF THE BROOD-CHAMBER.

If the new brood-chamber is contracted so that little work is required to fill it and so that most of the bees of the colony are crowded into the supers, the work in the supers should continue without interruption after a swarm has been hived. It was formerly a common practice to reduce the new brood-chamber to five or six Langstroth frames by inserting division boards at the sides of the hive to fill out the remaining space. This should not be done until two or three days after the swarm has been hived, for contracting the brood-

chamber at the time of hiving the swarm may cause the bees to swarm out.

Contraction of the brood-chamber forces the bees to do most of their work in the supers; therefore a good crop of honey may be obtained in this way even during a short honey-flow, but after the honey has been removed from the hive at the close of the season such colonies are practically without stores and should either be reunited with the parent colony or supplied with a sufficient quantity of honey for fall and winter stores. This can be done easily by leaving for the bees a second hive body with combs which are practically filled with sealed honey.

Combs of honey and combs containing only sealed brood, together with honey and pollen in the new brood-chamber, have an effect similar to that of contraction of the brood-chamber. Combs with most of the honey sealed should not be used for this purpose unless they are placed at the sides, since such combs in the middle of the new brood-chamber may cause a stagnation of colony activity (pp. 13 and 15).

SWARMING OUT.

After a swarm has been hived it sometimes deserts the new hive or "swarms out." This may occur the day the swarm is hived, or the next day, and sometimes even on the third day after hiving. It may occur either with natural swarms or with artificial swarms. Swarming out apparently is often caused by a lack of room in the new hive or by discomfort from some other cause, though occasionally a newly hived swarm may leave the hive when no cause for their dissatisfaction is apparent. This trouble may be prevented or greatly reduced by placing an empty hive body, without frames, below the new brood-chamber for two or three days, by providing ample ventilation and shade for the new hive at the time of hiving the swarm, and by using one or more empty combs which have been used previously for brood-rearing in the new brood-chamber instead of frames of foundation exclusively. Combs of unsealed brood are not recommended for this purpose. Entrance guards or queentraps may be placed on the entrance of the new hive for a few days to prevent the queen escaping, if newly hived swarms are inclined to swarm out, but the trouble usually can be prevented by making provision for the comfort of the bees, especially for the first day or two.

When artificial swarming is practiced (p. 34) in comb-honey production, swarming out can be prevented by taking away the combs of brood in two installments, with an interval of three or four days between. In the first operation half or more of the brood should be taken away and frames of foundation given in their place, and three or four days later all the remaining combs of brood should be removed.

UTILIZING THE PARENT COLONY FOR PRODUCTION.

In the usual plan for hiving natural swarms, the swarm is used as the producing colony, the parent colony being deprived of most of its bees to give greater strength to the swarm. The massing of most of the bees of both the swarm and the parent colony into one hive is necessary for best results when swarming occurs during the honey-flow and especially so when the honey-flow is short. It is, however, sometimes desirable to mass the bees together in the parent colony instead of in the swarm. This may be accomplished by returning the swarm without the queen to the hive from which it came. Seven days later all but one of the queencells should be destroyed, the remaining cell being left to requeen the colony.

Great care must be taken in destroying the queencells to be sure that only one is left, for if more than one queencell is left the colony may be expected to swarm soon after the first young queen emerges. It is usually necessary to shake most of the bees from each comb as the combs are examined for queencells in order to be sure that no queencells are overlooked. The comb containing the queencell that is to be left should not be shaken, since if this is done the immature queen may be injured.

It sometimes happens that some colonies treated in this way will swarm soon after the young queen emerges from the one cell that was left, leaving the parent colony greatly depleted in bees and hopelessly queenless. Again, the queen may fail to emerge, in which case, unless a queen or another queencell is supplied promptly, the colony, being hopelessly queenless, works with reduced energy and later, of course, would become depleted. For these reasons some beekeepers prefer to destroy all the queencells five days after the swarm has issued, then again five days later, at which time a young laying queen is introduced by means of an ordinary introducing cage.

By hiving the swarm back into its own hive without the queen and permitting the colony to rear only one young queen, or leaving them queenless 10 days and then introducing a laying queen, the colony is left in a condition comparable to the parent colony in nature, except that it retains all of the workers instead of losing the bees of the swarm. Such colonies usually do not swarm again the same season. This method does not require extra hives and equipment, but it probably involves some loss in the less energetic work while the colonies are queenless.

TREATMENT TO ANTICIPATE SWARMING.

The emphasis given to the care of natural swarms on the preceding pages is largely for the purpose of bringing out the principles which underlie the successful methods used to anticipate swarming. Com-

mercial honey producers who operate several apiaries can not afford to permit natural swarming but must use some system by which swarming can be controlled by visiting each apiary at certain intervals and applying remedial measures if preventive measures are not sufficient. Producers of extracted honey who have good combs, good equipment, and a good strain of bees usually can control swarming to a sufficient degree, in many locations at least, by ordinary preventive measures and good management, so that it is not necessary to examine every colony once a week to see if preparations for swarming are being made. In some locations, however, the swarming tendency is so strong (p. 12) that the greatest skill in the application of preventive measures is not sufficient to prevent loss, and some remedial measure must be applied.

Comb-honey producers in regions suitable for commercial comb-honey production (see *Farmers' Bulletin* 1039) find that while preventive measures may greatly reduce swarming it is usually necessary to treat many of the colonies for swarming during ordinary seasons, while during occasional seasons it may be necessary to treat most of them.

Swarming can be anticipated by creating conditions within the hive comparable either to those of a recently hived swarm or to those of the parent colony, and it is not necessary to wait until the swarm actually leaves the hive to do these things. In either case the necessary steps can be taken at the convenience of the beekeeper before the colony casts a swarm. To anticipate swarming, the beekeeper, therefore, as the first step, either takes away the combs of brood and arranges for the establishment of a new brood-nest, or he takes away the queen and destroys all queen-cells, if any are present. In some cases the removed brood is not taken entirely away from the colony but is separated from the queen and the new brood-chamber by means of a queen excluder, and in some cases the queen is not taken from the hive but is caged within the hive during the required interval, then released among the combs of brood. The subsequent behavior of the colony is practically the same as that of a natural swarm in the one case and that of the parent colony in the other.

In the operation of out-apiaries or of any apiary in which an attendant is not present the beekeeper should use every precaution to prevent swarming (pp. 6-19); then, as the swarming season approaches, it may be necessary for him to examine the strongest colonies to determine if queen-cells are being built. If any such are found, it now becomes necessary either to begin a systematic examination of each colony every week or ten days during the swarming season for indications of preparations for swarming and to treat those colonies which need treatment, or to treat all of the colonies, whether or not

preparations are being made for swarming. Much will depend upon circumstances as to which of these plans is more desirable. The uncertainty of weather conditions during the early honey-flow in many parts of the country makes it difficult in comb-honey production to devise any system that will work out advantageously year after year by which all the colonies can be treated at the same time. In extracted-honey production, however, this may well be done.

If the plan of examining each colony for queen-cells once a week is to be carried out, the queen-cells in colonies which contain only eggs or small larvæ are destroyed, since some colonies will give up swarming when this is done. If the queen-cells are well advanced containing large larvæ, the colony should be treated at once, since the removal of such queen-cells can not be expected to deter swarming. When destroying newly started queen-cells in this way most of the bees should be shaken from the combs as they are examined, to be sure that none are missed, since if but one queen-cell is left the destruction of the remainder of the cells would have no effect upon the preparations for swarming.

The methods given in the following paragraphs are illustrative of different types of remedial measures. The various methods here outlined are by no means equally suitable for every locality or every season in a given locality. It is necessary for each beekeeper to work out a system for swarm control to meet the requirements of his particular locality and season. The underlying principles, however, are the same throughout the multitude of methods, and the following outlines are given to illustrate the principles involved, rather than to indicate definite systems to be followed.

CREATING CONDITIONS COMPARABLE TO THE SWARM.*

1. Shake the bees from their brood-combs back into the brood-chamber, placing the combs of brood in an extra hive body as the bees are shaken from them and putting in their places frames of foundation and one empty comb, or whatever is to be used in establishing the new brood-nest as in hiving swarms (p. 29). To avoid the necessity of finding the queen, the combs should be shaken or brushed sufficiently free of bees to insure that the queen is left in the hive when the brood is all taken away. If extracted honey is being produced, put a queen-excluder over the brood-chamber, replace the supers, and finally place the hive body now containing the removed brood on top as though it were an additional super.

* Colonies that are building queen-cells in preparation for superseding should not be subjected to this treatment, but the failing queen should be removed, the queen-cells destroyed, and the colony treated as a parent colony (p. 39). Such colonies can be distinguished from normal colonies which are preparing to swarm by the imperfect work of the queen, the smaller number of queen-cells, and the general condition of the colony as to population and proportion of emerging bees.

first destroying all queencells if any have been started. Ten days later again destroy all queencells that are built on the combs of brood now above the supers.

To accomplish the same thing without shaking the bees from the combs, find the queen and place her, together with a comb of brood and adhering bees, in an extra hive body which is filled with frames of foundation or empty combs as described above. Lift the original brood-chamber from the bottom-board and put the extra hive body now containing the queen in its place. Put the queen-excluder and the supers in place and finally place the original brood-chamber above the supers, first destroying all queencells, if any have been built. Ten days later destroy all queencells in the original brood-chamber. When a comb of brood is placed in the new brood-chamber in this way, care must be taken that it does not contain any queen-cells, and if preparation for swarming is general in the apiary it is not advisable permanently to leave this comb in the new brood-chamber, because if preparation for swarming has already been in progress the bees sometimes start queencells on this comb of brood and later cast a swarm. When the bees are inclined to do this, the frame of brood should be removed a few days after the treatment.

As the brood emerges in the original brood-chamber the vacated cells are filled with honey during a good honey-flow and the former brood-chamber now becomes a super. If it contained some inferior honey when it was put above, which would reduce the quality of the crop, it may be better to reserve these combs of honey for winter stores. If increase is desired, this upper hive body of emerging brood may be removed from the hive a week or 10 days after it was put up and used to form a new colony. When this is done, the queencells should not be destroyed, unless it is desirable to give this new colony a queencell reared from better stock (see p. 7). If a queen-excluder has not been in use previously, it will be more difficult to find the queen as well as to destroy the queencells.

When comb-honey is being produced the procedure is practically the same, except in the disposition of the brood that is removed. This can not well be placed above the comb-honey supers and the emerging bees added to the colony as when producing extracted honey, but the emerging brood may be placed in a separate hive located by the side of the original hive (fig. 7), so that a large number of the emerging bees may be united later with the swarm when they are old enough for field work, simply by moving the hive to another location while these young bees are at work in the fields (see p. 27).

When the brood is removed in comb-honey production it is necessary, therefore, to leave enough bees with the brood to care for it. This can be done by placing the hive body which contains the brood

back on the hive immediately after the shaking is complete, but placing it above a queen-excluder until enough bees return to these combs to care for the brood before it is established as a separate hive. Another way to do this is to find the queen before shaking any bees from the combs, then transfer two or three combs to the extra hive body without shaking off the adhering bees, in order to have bees enough in this hive to care for the brood, the queen, of course, being put back into the brood-chamber on the old stand. In either case, if increase is made from this removed brood, these new colonies should be supplied with good queencells, since when artificial swarms are

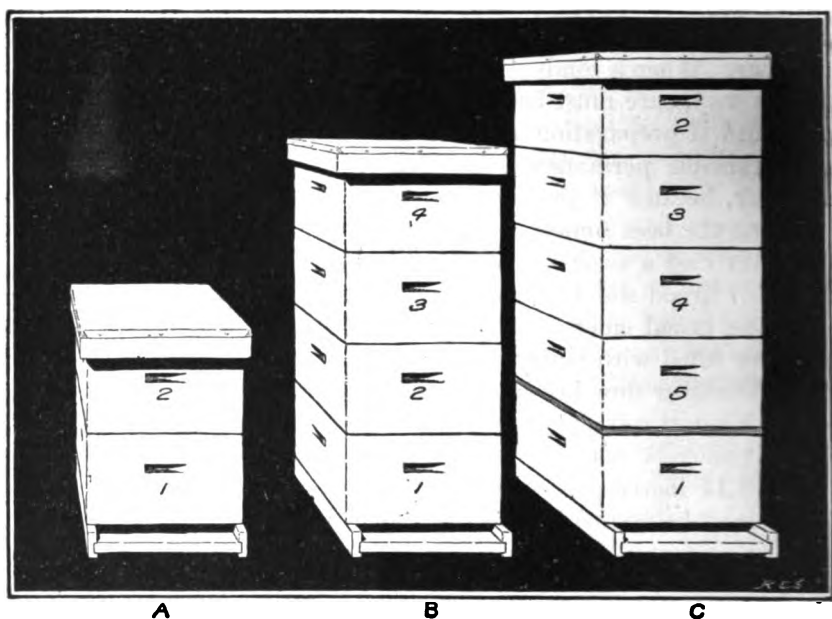


FIG. 8.—Creating conditions comparable to a swarm. Plan 2 for extracted honey. *A*, Brood in both hive bodies in the spring. *B*, Supers 3 and 4 are added as more room is needed, queen usually abandoning lower brood-chamber (1). *C*, Queen placed below excluder in lower hive body (1) after all brood in this chamber has been sealed. Empty super (5) is added and brood (2) is placed on top.

made in this way conditions often are not as favorable for the development of a good queen as in the case of the parent colony in natural swarming.

2. Use two hive bodies for brood-rearing previous to the swarming season. For extracted honey, add supers of empty combs above these two hive bodies as soon as more room is needed and do not use a queen-excluder. (Fig. 8, *A*.) Under these conditions the queen usually abandons the lower hive body as the season advances. (Fig. 8, *B*.) Ten days or more after she has abandoned it, when all the remaining brood in this hive body will have been sealed, find the queen, put her into the lower hive body, and confine her thereby means

of a queen-excluder. (Fig. 8, *C*.) Place the supers directly above the queen-excluder and finally place the hive bodies recently occupied by the queen on top of the supers. Conditions now are similar to those present when a swarm is hived on frames containing none but emerging brood together with pollen and honey and the parent colony is placed on top of the supers (p. 26). Ten days later the queencells that have been built in the meantime usually should be destroyed, though this is not always necessary (p. 26). This plan is useful in extracted-honey production provided the honey-flow is not greatly prolonged. It may not be sufficient completely to control swarming during a prolonged honey-flow, since the colonies may later

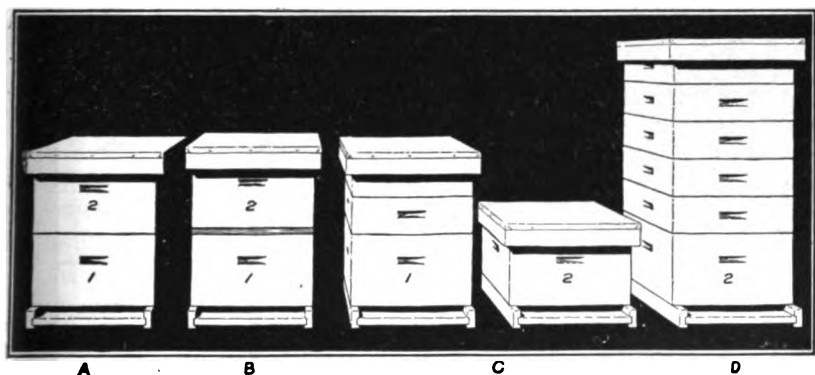


FIG. 9.—Creating conditions comparable to a swarm, but later comparable to a parent colony. Plan 2 modified for comb-honey. *A*, Brood in both stories in the spring. *B*, Queen-excluder inserted ten days previous to honey-flow. *C*, Queen transferred to brood-chamber from which she has been excluded at beginning of honey-flow. In the illustration it is assumed for convenience that the queen was confined to 2 when the excluder was inserted, which is here shown at the right as a separate hive supplied with a ripe queencell. The queen may have been confined to 1 instead, in which case she is transferred to 2, which is left on the old stand, and the queencell is given to 1, which is placed at one side. *D*, The brood-chamber containing the young queen (2) is substituted for the one containing the old queen (1) after the young queen has begun to lay.

again prepare to swarm. For a long honey-flow plan No. 3 may be preferable.

This plan does not lend itself readily to comb-honey production, because bees usually do not begin work well in comb-honey supers when two hive bodies are used for the brood (fig. 9, *A*), and the queen therefore may not abandon the lower hive body, as she does when extracting combs are used in the supers. For comb-honey production, however, a queen-excluder may be inserted between the two hive bodies 10 days previous to the time of putting on the comb-honey supers, the queen being in this way excluded from one of them. (Fig. 9, *B*.) After 10 days, by removing and examining a single comb for eggs and larvæ, it can be determined which hive body contains the queen. The queen should then be transferred to the hive

body from which she has been excluded either by finding her or by shaking all of the bees, including the queen, from the combs. The hive body to which the queen has just been transferred is left on the old stand as the new brood-chamber and the hive body from which she was taken is now removed and managed as a parent colony. (Fig. 9, *C*.) This treatment may be sufficient when the honey-flow is short in duration, but if the honey-flow is long, swarming may be only delayed by this process. However, by giving a ripe queen-cell to the parent colony soon after the division is made, then after the young queen begins to lay substituting the brood-chamber containing the young queen for the brood-chamber containing the old queen,

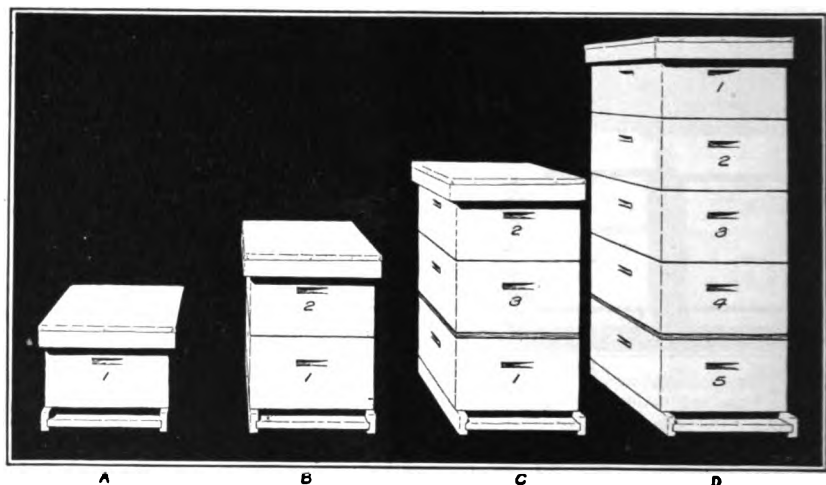


FIG. 10.—Creating conditions comparable to a swarm. Plan 8 for extracted honey. *A*, Colony in single story in early spring. *B*, Second brood-chamber (2) is added when more room for brood-rearing is needed. *C*, Ten days later the queen is placed below excluder (1), super (3) is added, and brood-chamber (2) is placed on top. *D*, Ten days later the queen-cells in brood-chamber (2) are destroyed, the queen is placed in lowest hive body (5) which contains empty combs or combs and foundation, the queen being confined to this chamber by a queen-excluder; empty super (4) is added and brood-chamber (1) is placed on top.

conditions comparable to the parent colony (p. 39) are created. (Fig. 9, *D*.) Such colonies, as a rule, do not attempt to swarm again the same season.

3. When the bees need more room for brood-rearing in the spring, give a set of brood combs (preferably old, dark combs), placing them on top of the original brood-chamber. (Fig. 10, *A*, *B*.) If the colony is strong at this time the queen will enter this added brood-chamber promptly, usually neglecting the lower hive body until the upper one is filled with brood, honey, and pollen. Ten days later, or at about the time of the beginning of the honey-flow, the brood in the lower story should all be sealed. At this time transfer the queen to the lower hive body, either by finding her or by

shaking the bees from the combs, from the upper into the lower hive body, and confine the queen below by means of a queen-excluder. (Fig. 10, *C*.) If the honey-flow is beginning, add a super of extracting combs (fig. 10, *C*), then place the recently used brood-chamber on top as a third story. Ten days later destroy all queen-cells in the queenless brood-chamber, then shake the bees together with the queen from the combs in the lower brood-chamber, placing the combs of brood into an empty hive body and giving back either empty combs or frames of foundation, together with one empty comb. Replace the queen-excluder and the supers, adding an additional one if needed, and finally place the brood-chamber containing the brood just removed on top of the supers. (Fig. 10, *D*.) To avoid shaking, the queen may be found, and together with a frame of brood, she may be placed in the extra hive body containing the empty combs or foundation, after which this extra hive body is put in place of the former brood-chamber, and the former brood-chamber is placed on top of the supers. This double treatment is not always necessary, but should completely control swarming in localities where the swarming tendency is strong.

This plan can be modified for comb-honey production if the colonies are strong by putting the queen down into the lower hive body after she has abandoned it long enough for all the brood to be sealed, removing the upper hive body entirely, the bees being shaken from the combs into the lower hive body, and one or two comb-honey supers being given. The brood that is taken away may be placed above queen-excluders on another colony not now being used for comb-honey. Six or seven of these brood-chambers may be given to each colony that is used for this purpose. Ten days later treat each colony as in plan No. 1 above, substituting for their brood-combs the combs of emerging brood that were removed before, first destroying all the queen-cells, if any are present. The combs of brood that are removed during this operation may be put into a separate hive and handled as a parent colony (fig. 7) or disposed of in some other way. Thus the bees are shaken twice, with an interval of 10 days between, on combs containing none but emerging brood (p. 29).

CREATING CONDITIONS COMPARABLE TO THE PARENT COLONY.

1. When the bees begin to make preparations for swarming, find and remove the queen. If it is desirable to keep her, she may be placed in another hive, together with the comb of brood on which she was found, to form a nucleus, or she may be killed if not needed. If queen-cells have already been started these should all be destroyed at the time the queen is removed. Ten days later again destroy all queen-cells, being careful to shake most of the bees from the combs

as they are examined to be sure that none are overlooked. Either at this time or a few days later introduce a young queen that has just recently begun to lay, by means of an ordinary introducing cage, which may simply be thrust into the entrance of the hive until the queen has been released.

Some beekeepers, instead of introducing a young laying queen, destroy all but one of the queencells and permit the colony to requeen itself from this remaining queencell, but in some cases such colonies will swarm soon after the young queen emerges from the cell, especially if the colony had made preparations for swarming before being treated (p. 32).

Instead of introducing a young queen, the original queen may be returned to her colony, the same care being used in introducing as with any other queen. It is not necessary to return the same queen, but a queen may be taken from any colony for this purpose. If the original queen is to be returned to the colony, she may simply be caged within the hive during the interval of 10 days instead of being taken from the hive, then a few days after the queencells have been destroyed she may be released among the bees. Practically the same result can be accomplished without finding the queen by shaking the bees together with the queen into the brood-chamber, which is now left empty except for one comb. The queen should be confined to this nearly empty hive body by means of a queen-excluder, the brood being placed above the excluder in another hive body. (Fig. 11, *A, B*.) After the queen has thus been separated from the brood for 10 days the queencells should all be destroyed and the extra hive body should be removed (fig. 11, *C*), the queen and the bees in this hive body being returned to the original brood-chamber. When the old queen is returned to the colony in this way, however, the tendency to prepare for swarming again is considerably stronger than when a young queen that has just begun to lay is given. A colony to which a young queen is given after an interval of queenlessness of at least 10 days is more nearly like a parent colony in nature and usually does not prepare to swarm again the same season.

When two hive bodies are used for brood-rearing previous to the honey-flow, these two-story hives may be divided at the beginning of the honey-flow, leaving most of the brood in the hive on the old stand, the queen and the remaining brood together with some adhering bees being placed in the other hive body, which is now supplied with a cover and bottom and set near the original hive. If any queencells are present at the time the division is made, these must be destroyed. The supers are given to the now queenless colony on the old stand. Ten days later the queencells should be destroyed and a young queen introduced, as described above. The two colonies

may be reunited at the close of the honey-flow if comb-honey is being produced, or before the close of the honey-flow if extracted honey is being produced.

2. If the bees have been wintered in a single brood-chamber, give a second brood-chamber when the colonies need more room in the spring, placing this second brood-chamber on top. When old brood combs are used in this second brood-chamber, the queen usually goes into it within a few days. After a week or 10 days divide the colony by removing the upper hive body, which usually at this time contains the queen, and place supers on the hive body which remains on the old stand. If the nights are cool, such a division may result

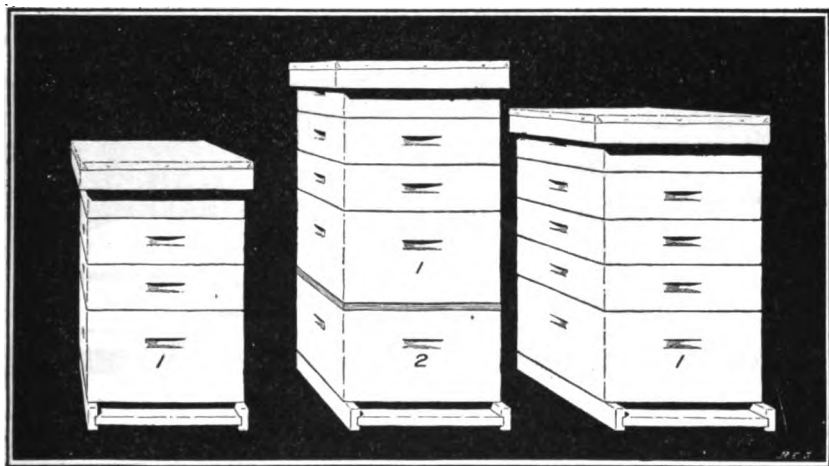


FIG. 11.—Creating conditions comparable to a parent colony. Plan 1 modified to return the original queen after her separation from the brood for ten days. *A*, Colony preparing to swarm. *B*, Bees together with queen shaken from all but one of combs of brood, these combs being placed in second story (1) above a queen-excluder, thus confining the queen in a nearly empty hive body (2) below the brood. *C*, Ten days later all queen-cells are destroyed and the queen is returned to the brood, the extra hive body being removed.

in the loss of some brood in the brood-chamber that is removed, for it is the youngest of the brood that is removed. After the brood is all sealed in the brood-chamber on the old stand destroy all queen-cells and introduce a young laying queen or permit this division to requeen itself by leaving one queencell (p. 40). The two divisions may be left standing side by side in order that they may be reunited later. If extra covers and bottoms are not available, the division may be made by using an escape board as a cover for the hive on the original stand, having the bee-escape removed and the hole for the bee-escape entirely closed, the brood-chamber containing the queen being on top of this escape board and the regular cover used over all. In this case an entrance should be provided for the upper hive body by pushing it forward on the escape board until an opening of suffi-

cient size is formed. If extracted honey is being produced, this escape board may be removed before the close of the honey-flow to unite the two divisions, in which case the bees will kill the old queen later, if not at this time; thus the colony is requeened without the necessity of finding the queen.

3. Use two hive bodies for brood-rearing during the spring. Previous to the swarming season, insert a queen-excluder between the two hive bodies to confine the queen to one of them. Ten days later divide the colony by removing the brood-chamber which contains the queen, leaving the queenless portion on the old stand. To determine which hive body contains the queen, it is only necessary to remove one of the brood-combs from the middle of the brood-chamber to look for eggs or young larvæ, since in the brood-chamber from which the

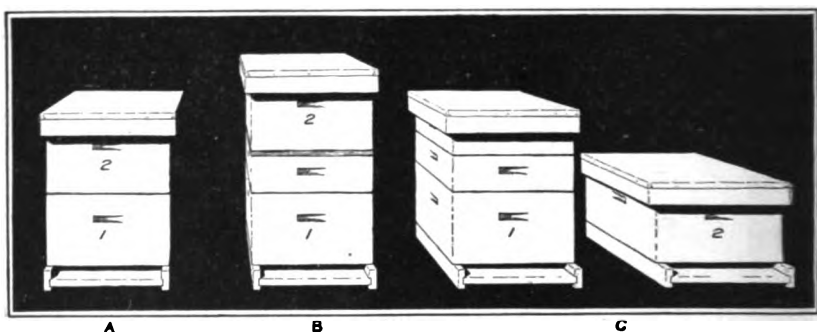


FIG. 12.—Creating conditions comparable to a parent colony. Plan 3 as modified for comb-honey. *A*, Brood in both stories previous to honey-flow. *B*, Comb-honey super and queen-excluder inserted between two hive bodies at beginning of honey-flow. It is not known at this time which hive body contains the queen. *C*, Hive body containing the queen (2) removed and established as separate hive. Queen-cell is placed in 1. In the illustration it is assumed that the queen was in 2 when the queen-excluder was inserted in *B*. She may have been in 1 at that time, in which case, of course, this brood-chamber is removed.

queen has been excluded the brood is all sealed at this time. Supply the queenless portion with a young laying queen or a ripe queen-cell. The two divisions may be reunited later or that portion containing the old queen may be moved to a new location for increase (p. 27) a week or 10 days after the division, whereupon the field bees from the removed hive will return to the hive on the old stand, thus strengthening the colony that is working in the supers. If extracted honey is being produced the division containing the old queen may be reunited with the other division two weeks later by placing the brood-chamber above the supers, in which case the bees will probably kill the old queen later in the season if not at this time. By this plan it is not necessary to find the queen.

For comb-honey production this treatment may be applied at the time the first comb-honey super is given. This comb-honey super may be placed between the two hive bodies if preferred (fig. 12, *A*, *B*), to

cause the bees to begin work in it more readily, the queen-excluder being placed above the comb-honey super. An escape board without the bee-escape should also be placed over the comb-honey supers to prevent the sections being soiled from the brood combs above and at the same time permitting communication between the two hive bodies through the hole in the escape board, or the queen-excluder can be dispensed with by tacking a piece of perforated metal over the hole in the escape board. In this case the upper hive body usually should not be left for the full 10 days but the division may be made earlier to prevent the sections being soiled and to cause the bees to store incoming nectar in the sections, instead of in the upper brood-chamber. After four or five days the presence of eggs and small larvæ indicates which brood-chamber contains the queen, after which the division may be made at any time up to 10 days, the queenless division being left on the old stand. Ten days after the queen has been excluded from the brood-chamber now left on the old stand, all queencells should be destroyed and a ripe queencell or a young laying queen should be given. (Fig. 12, *C*.)

RADICAL CHANGES UNNECESSARY NEAR CLOSE OF SEASON.

During the latter part of the honey-flow colonies that are preparing to swarm may be induced to give up swarming much more easily than earlier in the season. In fact as the season is drawing to a close colonies having sealed queencells preparatory to swarming sometimes tear down such cells of their own accord and give up swarming for the season.

Natural swarms that issue near the close of the honey-flow may be hived in an empty box, which is placed by the side of the parent colony for 24 to 48 hours, then hived back into their own hive. After the swarm enters the parent colony the queencells are usually destroyed and the bees apparently are satisfied. If this is done earlier in the season, however, further swarming usually results.

Colonies that are preparing to swarm near the close of the season may be induced to destroy their own queencells and give up swarming by moving the hive away and substituting another hive containing two combs of brood (some unsealed brood is necessary) without queencells, the remaining space in the brood-chamber being left vacant. The supers are then transferred to the prepared hive on the original stand, and the queen is left in the original hive which is set at one side or on top of the prepared hive. (Fig. 13, *A, B*.) If the bees are well at work in the fields when this is done and the original hive is so located that the returning bees do not enter it, but enter the prepared hive, the original hive becomes so depleted of bees that the queencells are destroyed and swarming is given up. The other division can not swarm because it has no queen. After four or five

days the original hive may be restored to its former position (fig. 13, *C*) and the bees of the queenless portion shaken from their combs back into the original hive, thus reuniting the colony.

These cases may be useful near the close of the season or at any time if the tendency to swarm is not great, but neither of them can be depended upon during the height of the swarming season, for the conditions which were present previous to preparations for swarming are soon restored under this treatment.

THE CAUSE OF SWARMING.

While the cause of swarming has not been definitely determined, the one factor which is universally present in normal swarming

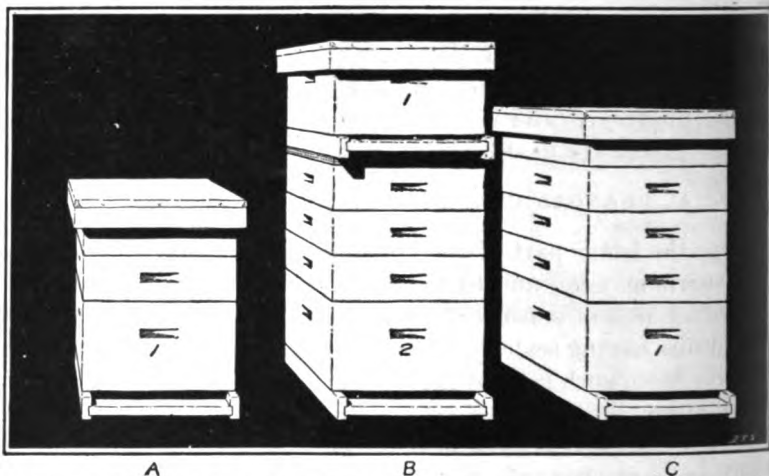


FIG. 13.—Method for inducing bees to destroy queen cells and give up swarming. *A*, Colony preparing to swarm. *B*, Hive (2) containing two frames of brood (some of which is unsealed) is substituted for the original hive (1), which is now placed on top, communication between hives 1 and 2 being permitted. *C*, Hive 2 is removed after a week or ten days and hive 1 is restored to its former position.

that of a congestion of bees within the brood-nest. Other factors often mentioned as causing swarming are not universally present. Such a congestion of bees within the brood-nest is usually brought about by a preponderance of recently emerged and emerging young bees, but the effect of such crowding may be greatly intensified by numerous factors in the environment, not universally present, which may be considered as contributing factors, but not causal. Whether preponderance of bees too young for outside work or some other factor is responsible for swarming, this theory forms a good working hypothesis, since the successful preventive measures are those which reduce the congestion or alleviate its effects, and the successful corrective measures are those by which the balance in the proportion of hive bees and field bees is restored. In natural swarming as

s in the various methods that have been worked out to anticipate swarming, there is a break in the continuity of emergence of young bees within the hive, either at the time of the operation or a few weeks later. This reduction in the number of oncoming young bees is apparently an essential part of any successful treatment for swarming.

When a queen is being superseded during the swarming season the colony may swarm, even though it is lacking in a preponderance of young bees, which is present in normal swarming. In this case the presence of queen-cells begun in response to the superseding impulse apparently brings on the issuing of the swarm. Such swarming differs in many respects from normal swarming (p. 34).

When a queen is removed or is lost by some accident several queen-cells are usually built, and when the young queens begin to emerge swarming may be expected even though the conditions conducive to normal swarming are absent. Such colonies apparently swarm because of a plurality of emerging queens, behaving in this respect like parent colonies in casting after-swarms and quite unlike the behavior in normal swarming.

SUMMARY.

Among the factors that contribute to the tendency to swarm are (1) those connected with inbred characteristics, (2) those connected with the size, shape, and arrangement of the hives and the character of the combs (immediate environment), and (3) those connected with the distribution of the bees as brought about by the peculiarities of the season, the locality, and the management (general environment).

Inbred characteristics.—Some strains of bees have a stronger tendency to swarm than others. To some extent, therefore, swarming may be reduced by careful selection in breeding.

The hive and combs.—Colonies of bees having large brood-chambers are less inclined to swarm than those having brood-chambers so small. Strong colonies having good queens may need 60,000 to 100,000 cells for the rearing of brood, during the period of extensive brood-rearing in the spring, in addition to the cells used for the storage of honey and pollen.

Colonies of bees having good combs throughout are less inclined to swarm than colonies having poor combs. Inferior combs may greatly increase the tendency to swarm, both by reducing the amount of available brood-rearing space and by acting as barriers in the way of free expansion of the brood-nest.

Spaces for idle bees, especially within the brood-nest, may reduce the tendency to swarm. Such space may be provided by wide spacing of the combs or by a deep space below the frames.

Colonies in hives which are well ventilated and well protected from the direct rays of the sun are less inclined to swarm than those in poorly ventilated hives exposed to the sun. Ample ventilation should be provided, hives should be painted white, and if the weather is hot during the swarming season shade-boards should be used over the hives.

Distribution of bees within the hives.—Probably the greatest single factor in the cause of swarming is a congestion of unemployed bees within the brood-nest or discomfort in this part of the hive from overheating and lack of ventilation. Colonies which build a barrier of sealed honey around the brood-nest during the spring, thus confining their activities to this limited space, may be inclined to swarm even when there is an abundance of empty comb in other parts of the hive.

When the bees increase brood-rearing in the spring so rapidly that young bees accumulate faster than they are able to take up work in the hive outside of the brood-nest, the tendency to swarm is usually strong unless there is a dearth of nectar at this time. This condition brings on the normal swarming season, and great care is necessary to bring about a better distribution of the bees to prevent crowding the brood-nest.

If to this condition there is added any factor which in any way interferes with the young bees leaving the brood-nest to take up work in the supers, the congestion of bees within the brood-nest is increased, since this condition causes field bees to remain within the hives when they should be at work in the fields. The giving of super room of such character and in such a manner that the increasing number of hive workers may be enticed from the brood-nest and given work to do in the supers is of the greatest importance in the prevention of swarming.

If anything causes the field bees to stay in the hive during the day, the congestion and discomfort are greatly increased and these idle field bees may become a serious factor in increasing the tendency to swarm. In nature when a swarm issues, the overcrowding of the brood-nest is largely relieved, both within the swarm and within the parent colony.

Some important swarm-preventive measures, therefore, are:

- (1) Careful selection of stock in breeding.
- (2) The use of brood-chambers large enough during the spring brood-rearing period to hold the maximum amount of brood without crowding.
- (3) The use of good worker combs in the brood-chamber to prevent a reduction of the available brood-rearing space.

(4) The arrangement of the brood combs to avoid barriers in the way of a free expansion of the brood-nest during the spring.

(5) Providing extra space for the bees within the brood-chamber by wider spacing of combs and a deep space below the frames.

(6) The use of large entrances during the swarming season, especially when the weather is hot, and in some cases additional openings for ventilation.

(7) Protection of the hives from the direct rays of the sun by the use of shade-boards or double covers.

(8) Painting the hives white, especially the cover, if a shade-board is not used.

(9) Management to prevent conditions favorable to the building of barriers of sealed honey around the brood-nest, or the breaking up of barriers of this kind if they already exist.

(10) Inducing the bees to expand into and occupy supers as rapidly as the honey-flow will justify during the first half of the honey-flow, or at the time the colony is rapidly expanding in numbers.

(11) Providing additional space in the form of empty combs for the ripening of incoming nectar, so that the field bees can immediately dispose of the nectar they bring into the hive, to prevent the beginning of any stagnation of the activities of the colony.

(12) Removing some of the emerging brood to reduce the number of emerging bees within the brood-chamber, thus producing a better distribution of the bees throughout the hive.

(13) The destruction of queencells, providing they have been started but recently. Frequently, however, other cells are immediately started after the queencells have been destroyed.

As a remedy for swarming the beekeeper relieves the congestion of bees within the brood-nest by creating conditions comparable either to the swarm or to the parent colony in nature.



WASHINGTON : GOVERNMENT PRINTING OFFICE : 1911

91.9: 1199

FARMERS' BULLETIN 1199
UNITED STATES DEPARTMENT OF AGRICULTURE

JUDGING SHEEP



IMPROVEMENT of the sheep industry depends to a great extent upon a more general understanding of what constitutes a good or inferior animal and a broader appreciation of the methods of judging individuals by a study of their external parts.

The success or failure of a breeder likewise depends largely upon his ability to place the proper weight on the various points which must be considered in selecting foundation stock. This ability can be gained only through a careful, systematic study, coupled with a great deal of practice in judging and handling sheep.

Contribution from the Bureau of Animal Industry

JOHN R. MOHLER, Chief

Washington, D. C.

July, 1921

JUDGING SHEEP.

G. H. BEDELL, *Animal Husbandry Division.*

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SOME ESSENTIALS IN SHEEP JUDGING.

Any one who engages in the keeping of sheep should have a fairly good knowledge of what to look for when selecting individuals for his flock. Upon his ability to place the proper weight on the various points which must be considered in the individual selected depends to a great extent his success as a constructive breeder.

It is probably true that the average person knows less about the method to follow and the points to look for in sheep than in most other types of livestock. With other stock the judge can depend almost entirely upon his eye in arriving at his decision; with sheep, however, he must not only use his eyes, but to verify his opinion he must handle the individual. The fleece on the sheep is very apt to cover defects which can be determined only by actual handling.

A good judge of livestock has a natural aptitude for the work, coupled with a great deal of practice. The best judges are those who are constantly at it, whether in the show ring, feed lot, or field. It is natural for them to be always comparing points and qualities of individuals and weighing their value.

THE SCORE CARD.

The beginner will find the score card a helpful guide in his judging work. The score card gives a detailed description of the parts of a perfect animal. It gives these parts in a systematic way and its use will help in learning a uniform system of judging and in developing an appreciation of the relative value of the various parts of the animal in relation to the whole. As soon as one has learned the art of properly observing the various parts of the animal and considering their respective importance the score card becomes unnecessary and comparative judging practicable.

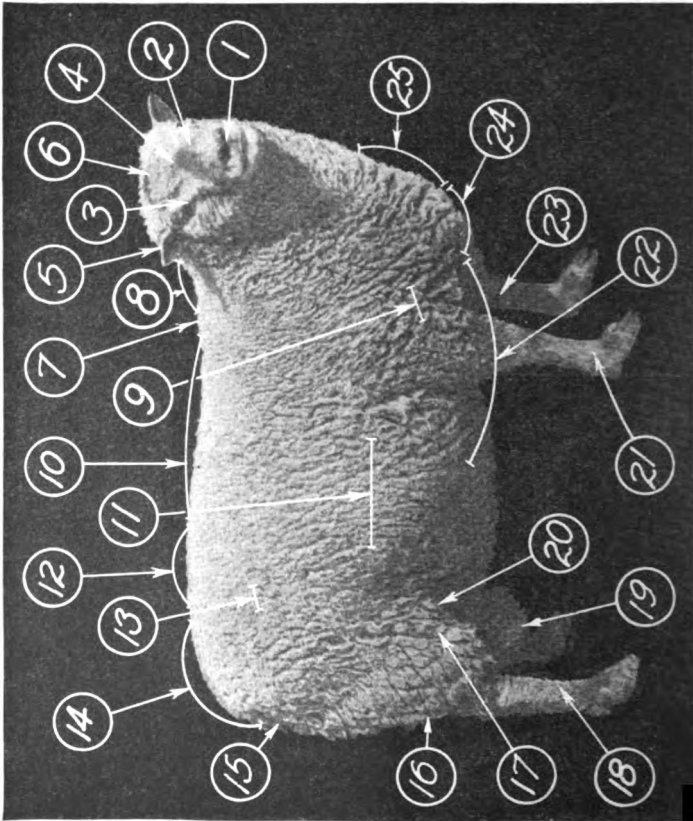
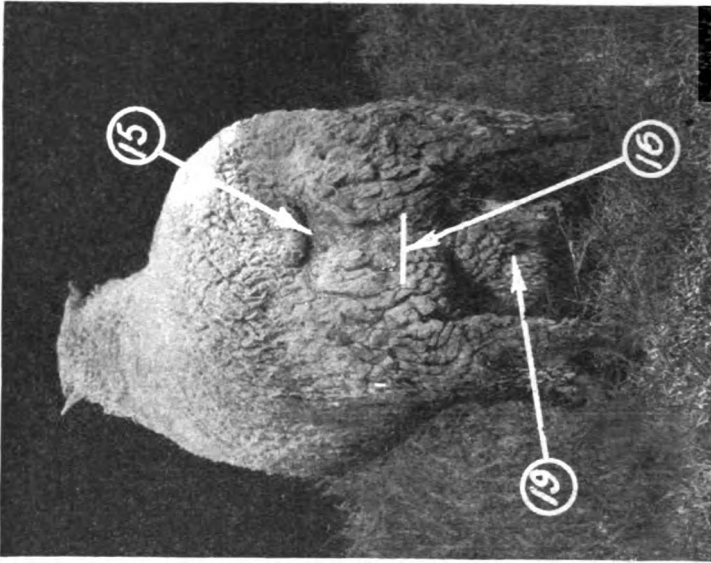


FIGURE 1.—The external parts of a sheep: 1, muzzle broad, lips thin, nostrils large; 2, face short, features clean-cut; 3, eyes large and clear; 4, forehead broad; 5, ears alert and not coarse; 6, poll wide; 7, top of shoulder compact; 8, neck short, thick, blending smoothly with shoulder; 9, shoulder thickly covered with flesh; 10, back broad, straight, thickly and evenly covered; 11, ribs long, well sprung, and thickly covered; 12, loins broad, thick, and well covered; 13, hips wide and smooth; 14, rump long, level, and wide to dock; 15, dock thick; 16, twist deep and firm; 17, thighs full, deep, and wide; 18, legs straight, short, and bone smooth; 19, cod or purse in wether, scrotum in ram, adder in ewe; 20, flank full and deep; 21, forelegs straight, short, and strong; 22, chest deep, wide, and full; 23, forelegs wide apart and forearm strong; 24, brisket full and rounding in outline; 25, breast well extended.

HOW TO USE THE SCORE CARD

From the score card learn to know the value to be given each part in terms of points. Use your judgment in making the score for each part. It takes a good animal to score 75 points out of the 100, and a choice one to score 90 points. By use of the score card, study the animal to learn where the various parts of the animal are located and what the words used in describing a part of the animal mean. Study the full-grown animal, then study animals of different ages of the same breed, noting wherein they differ from the mature animal. Familiarity with the description of the different types and breeds of sheep is also helpful.

Score Card for Judging Mutton Sheep

Scale of points	Possible score	Points given animal judged	
		Student's score	Instructor's score
GENERAL APPEARANCE.—25 points:			
1. Weight; pounds.....	5	-----	-----
2. Form; straight top and underline, deep, broad, low set for breed, compact, well proportioned.....	10	-----	-----
3. Quality; hair fine, bone fine but strong, features fine but not delicate, skin pink.....	10	-----	-----
CONDITION.—12 points:			
4. Flesh covering; deep, even, firm. Points indicating finish are fullness in shoulder and brisket, thick covering over top of shoulders, back, ribs, loin, thick dock.....	12	-----	-----
HEAD AND NECK.—9 points:			
5. Head; clean-cut, strong mouth, thin lips, large nostrils, large, clear eyes, alert look, face short, forehead broad, ears alert not coarse, considerable width between ears.....	5	-----	-----
6. Neck; short, thick, smoothly joined with shoulder.....	4	-----	-----
FORE QUARTERS.—10 points:			
7. Shoulders; compact on top, smoothly joined with neck and body and well covered with flesh.....	8	-----	-----
8. Brisket; full, round, and well extended.....	1	-----	-----
9. Legs; straight, short, wide apart.....	1	-----	-----
BODY.—18 points:			
10. Chest; deep, wide, full.....	2	-----	-----
11. Ribs; well sprung, long, close, and thickly covered.....	4	-----	-----
12. Back; broad, straight, thickly and evenly covered with flesh.....	6	-----	-----
13. Loin; wide, thick, well covered.....	6	-----	-----
HIND QUARTERS.—17 points:			
14. Hips; wide apart, level, smooth.....	1	-----	-----
15. Rump; long, level, wide, and thick at dock.....	4	-----	-----
16. Thighs; full, deep, wide.....	4	-----	-----
17. Twist; deep, firm, plump, joined well down on leg.....	5	-----	-----
18. Legs; straight, short, strong, wide apart.....	1	-----	-----
19. Udder or scrotum: Ewe's udder, well formed, large, and soft. In rams, both testicles large and well developed.....	2	-----	-----
WOOL.—9 points:			
20. Quantity; long, dense, even in density and length.....	3	-----	-----
21. Quality; crimp distinct and even, oil uniformly distributed throughout fleece.....	3	-----	-----
22. Condition; strong in fiber, clean, soft, and bright.....	3	-----	-----
Total.....	100	-----	-----

COMPARATIVE JUDGING

After you have become familiar with the score card and its use, and have had practice in comparing the points of many animals with the ideal described in the score card, you are ready to do comparative judging.

With comparative judging, instead of balancing the parts of the animal against the ideal, you compare the parts of several animals of the same kind. In doing so it is important to keep in mind the standard which they should approach.

Follow the same systematic order in making your comparison, part by part, of the individuals before you. For example, compare the heads of the animals in question and decide which one is superior in this particular. In comparative judging, a letter is given each animal, as A, B, and C. The beginner will find it best to write down the parts in which each animal excels, together with the way in which it excels.

After all the animals have been examined carefully and the comparison made for each, the best-balanced animal, that is, the one

most uniformly perfect in the largest number of important parts and without disqualifying weakness, should be placed first in the class; the next best, second; and so on. Keep clearly fixed in mind your reasons for placing any animal ahead of any other, and be able to give them verbally or in writing. In giving these comparisons do not try to describe each animal but tell wherein each is superior or inferior to the others. For example, where there are three breeding ewes in a ring, designated A, B, and C, and B is placed first, A second, and C third, the procedure would be as follows:

B was placed first because she has a stronger back, deeper body, larger leg of mutton, and a fleece that is of higher quality than A or C. A was placed second because she has a stronger constitution, as shown by her greater depth and width of chest, greater width of loin, and brighter skin than C. C was deficient in having a weak back, light hind quarters and a dull skin that shows she is out of condition.

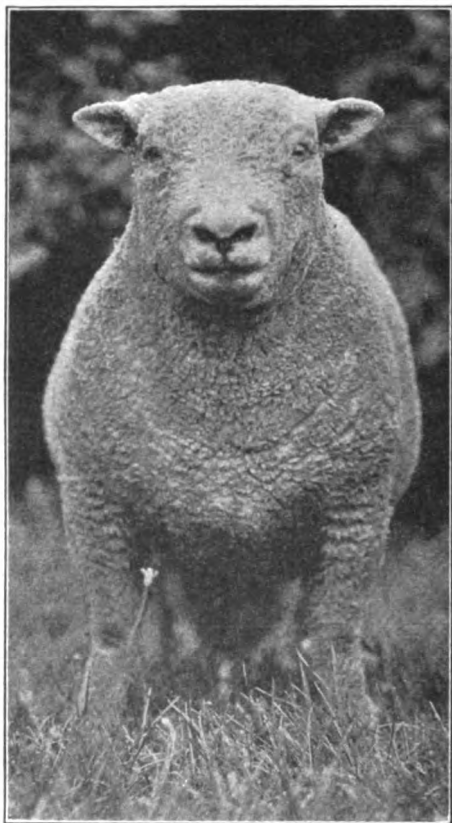


FIGURE 2.—Front view of a good mutton-type ram. This ram has a masculine head, is wide through the shoulders and floor of the chest. His legs are well placed, the bone is strong and smooth.

The beginner in judging sheep is apt to rush in and begin the actual handling too soon. It has been remarked that experienced judges at fairs and large shows begin handling at once. This is true largely because they have become able through practice to size up individuals very quickly with the eye, and thus begin handling immediately to verify their decisions.

HOW TO HANDLE THE SHEEP

After the sheep has been carefully inspected from a distance and the general make-up noted, verify your observations by going over the sheep with the hand. In doing this keep the fingers close together so as not to leave depressions in the fleece, for when the individual has been fitted for showing, sprawling fingers may easily mar the evenness and smoothness of the fleece.

Keep in mind the impressions you have gained of the animal when you come to the handling. If you do this you are not likely to make a mistake in your decision. Practice in judging is necessary to gain the correct touch. Pounding or clawing the animal is entirely out of order.

STEPS IN SYSTEMATIC JUDGING

The first step is to stand at a distance and get the general lines and make-up of the individual. The first estimate should be carefully and firmly impressed upon the mind. Strive for a mental picture of the individual, and fix the picture in the mind.

It will be best to follow some uniform system in judging a sheep, or a class of sheep. The following is suggested:

While viewing the sheep in front, note the make-up of the head; observe whether it is well proportioned. A ram should have a strong, bold head, showing masculinity (fig. 2); in the ewe a feminine appearance is desired (fig. 3). Note the width and depth of the brisket, and the length, shape, and general position of the front legs (fig. 4).

From the side observe the size of the animal and the general style, and notice whether the top line and the under line are parallel. The body should be of good length and depth in the most desirable individuals. Take special notice of the way the individual carries its head, whether the animal has the appearance of being sluggish or full of vigor. It is important to get in mind the length of the neck, its setting, and the relation of head and neck, body (or middle) and

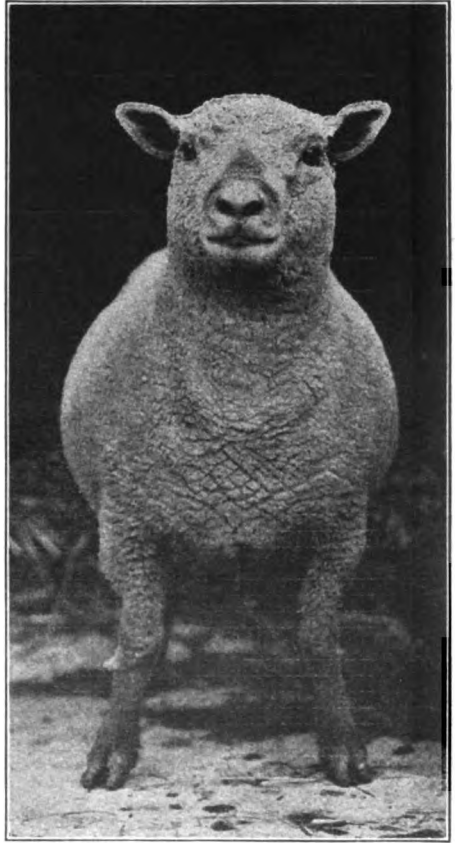


FIGURE 3.—Front view of a good mutton-type ewe. A ewe should show a more refined head than a ram.

rump to the total length. A desirable animal is well proportioned in these respects (fig. 5).

Now view the sheep from behind. Place special emphasis on the width of the rump, its straightness and evenness. The thighs should

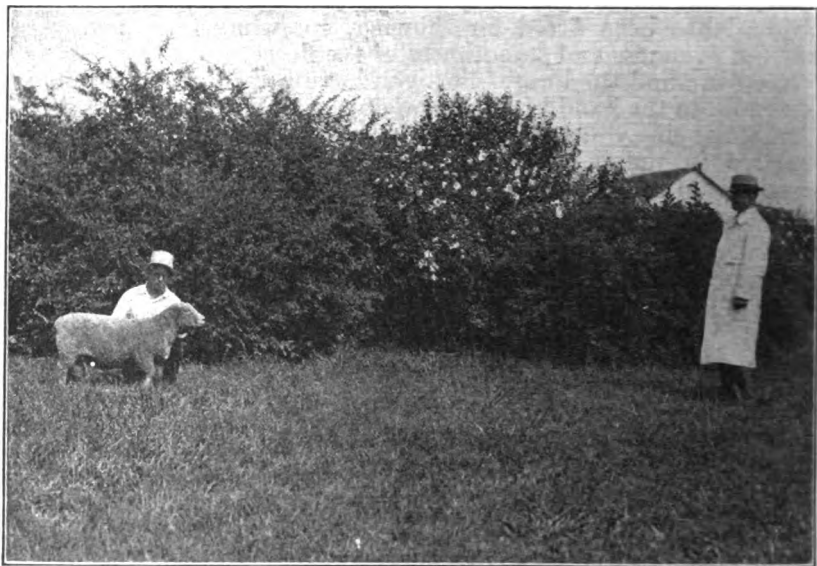


FIGURE 4.—Viewing sheep from the front.

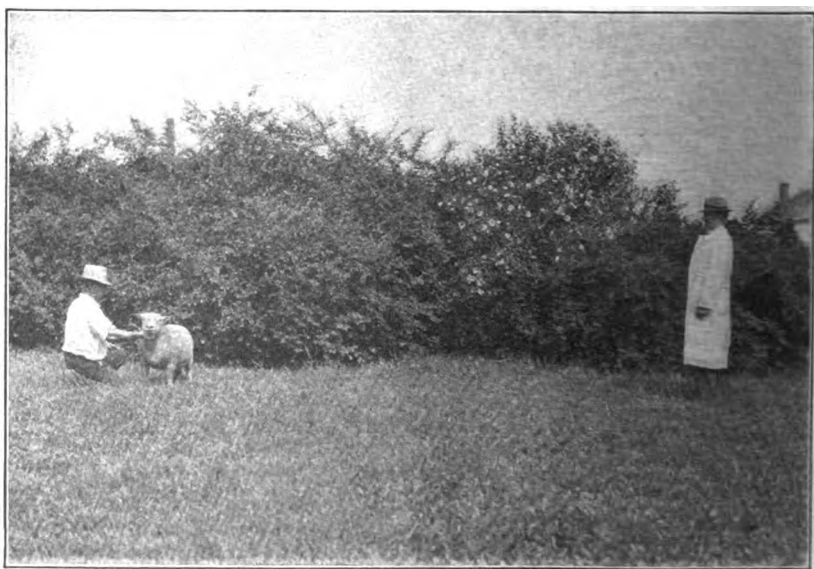


FIGURE 5.—Viewing sheep from the side.

be full and the twist deep. The hind legs should be well placed, strong, and of good size for the individual (fig. 6).

Close inspection of the head.—Observe the shape of the head. If the animal is a male, the head should be strong; if female, more

refined. Note the width of the face and forehead, the brightness of the eyes, and placement of the ears (fig. 7). Before leaving the head look at the teeth of the sheep to determine age (see p. 14).

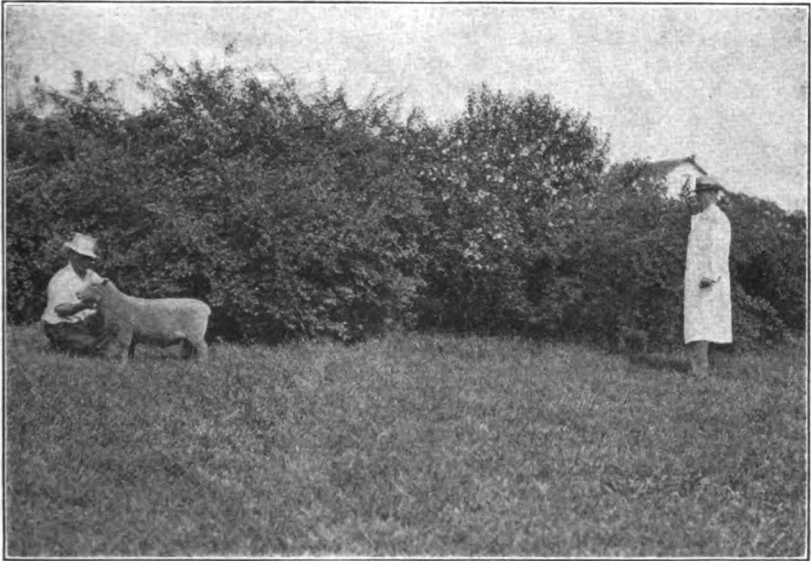


FIGURE 6.—Viewing sheep from the rear.



FIGURE 7.—Inspecting the head.

When judging rams of hornless breeds, place the fingers in the horn holes to determine whether there is any growth (fig. 8). Rams of hornless breeds should be free of scurs or growth of horns. With

the left hand determine whether there is in the throat any enlarged growth known as goiter.

Thickness of the neck.—The neck should be short and thick, smoothly attached at the head and top of shoulders. A ram's neck should be shorter and thicker than a ewe's (fig. 9).

Fullness of the neck vein.—The neck vein should be full and join smoothly with the shoulders. Fullness in the neck vein indicates high condition and a well-muscled neck (fig. 10). Touch the lower points of the shoulder to note whether the bones are unduly prominent or well covered with flesh.

Compactness on top of shoulders and depth of chest.—Place the right hand on the top of the shoulders to determine how compactly the shoulder blades are set up against the spine, also the covering of flesh over the top of the shoulders. Place the left hand on the floor of



FIGURE 8.—Inspecting the head of a hornless ram.

the brisket and chest to determine the width. Note the depth of chest by keeping the right hand on the top of the shoulder (fig. 11).

Condition of flesh and spring of rib.—By placing the hand just back of the shoulder blades, thumb and fingers forming a V, note the condition of covering and at the same time test the spring of ribs from the spine (fig. 12). A full spring of rib is desirable.

Width of chest.—It is important that a sheep be full in the chest. The flesh covering should be even and thick down over the ribs. There should be fullness back of the shoulder, indicated by the position of the hand (fig. 13). The ribs should be well covered and the spaces between the ribs should be well filled with firm flesh.

Strength and covering of the back.—By placing the hand firmly on the back with fingers together, note the strength and covering over

the back (fig. 14). Note carefully the spring of the ribs, especially the last rib, as the width of a well-shaped barrel or body increases gradually from the shoulders back to the last rib. In breeding ewes a large, well-sprung middle is desirable.

Width and thickness of loin.—Determine the width of the loin by putting one hand straight down on each side of it (fig. 15), and the thickness of the loin by placing the fingers flat over the spine and noting whether the bones are well covered with flesh.

Width and fullness of rump.—The rump should be level and carry its fullness out to the tail head. The hips should be wide apart and smooth, and the rump should be full in the position where the hands are shown (fig. 16). Grasp the dock and note its size and fullness. A wide, thick dock indicates deep, strong muscling along the spine. A good filling of fat on each side between the dock and rump indi-



FIGURE 9.—Inspecting the neck.

cates high condition, more important in fat sheep than breeding sheep.

Depth and fullness of twist.—Determine the depth and firmness of the twist by placing the left hand on the top of the rump, the right hand under the twist and pressing up slightly (fig. 17). A full twist is desirable as it helps to make a plump leg of lamb or mutton.

Development of the leg.—Determine the size of the leg of lamb or mutton by placing the left hand in front of the leg, close to the body and the right hand in the rear, as shown in figure 18. The leg should be of good size and full, and the fullness should be carried well down to the hock.

The fleece and skin.—After the conformation of the sheep has been determined, the fleece and skin must be carefully examined. The best wool grows on the shoulder or just back of it. Part the

fleece in this region by laying the hands flat on the surface and gently forcing it to part, as shown in figure 19. When the wool is open



FIGURE 10.—Fullness is required in the neck vein.



FIGURE 11.—Judging shoulders and chest.

note its density, quality, color, and condition. The skin in healthy animals is pink. Dark skin, bluish in color and harsh in feeling, may indicate poor health.

Determine the density of the fleece by grasping a portion between the thumb and finger. If the wool feels compact and fills the hand well it is likely to be dense.



FIGURE 12.—Noting condition of flesh and spring of rib.



FIGURE 13.—Determining flesh on ribs and girth over the heart.

Quality of wool is indicated by the waves or crimp in the fiber. When they are short and carry regularly from the skin to the outer tips of the fiber, the wool is fine and even in quality.

Condition of the fleece is determined by the color, yolk, and foreign material in the wool. Wool in good condition is bright, fairly clean, and free from chaff and burrs, with the oil or yolk evenly distributed.

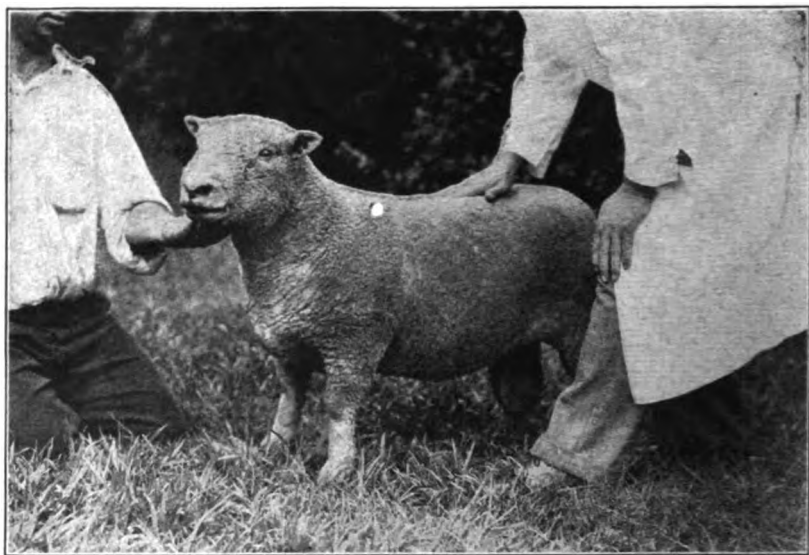


FIGURE 14.—Judging strength and covering of back.



FIGURE 15.—Determining the width of the loin.

The fleece on the thigh.—After the examination of the fleece on the fore part of the body, make a similar examination at the midside and on the thigh (fig. 20). In mutton breeds the quality and character

of the wool in the thigh should be as nearly like that on the shoulder as possible, and free from coarse fibers or kemp. In fine-wool breeds, examine the fleece also at the dock, on the belly, and other parts.



FIGURE 16.—Inspecting the rump.

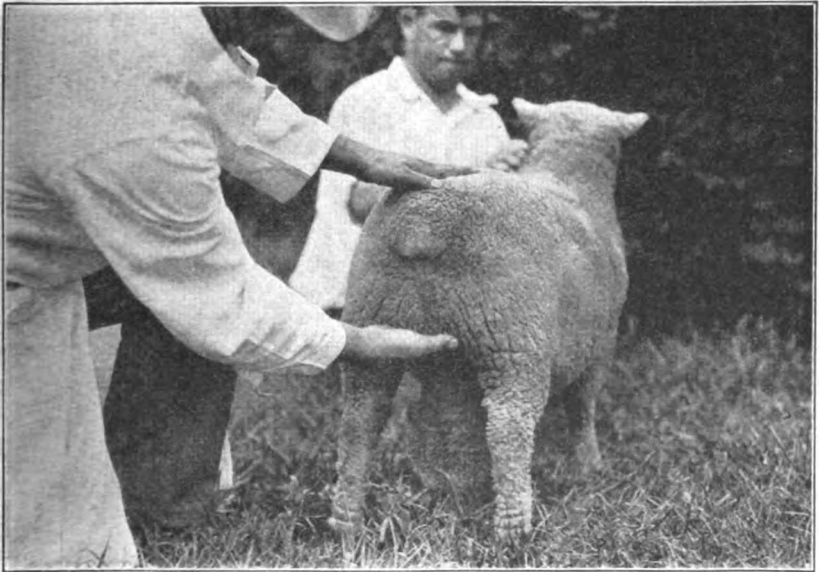


FIGURE 17.—Noting the depth of the twist.

When handling rams it is advisable to notice the scrotum. Both testicles should be normally developed. With ewes, examine the udder; if it is hard, or otherwise defective, some deduction should be made.

In judging fat sheep, note particularly whether the individual is "overdone." An excessive quantity of soft, loose fat over the ribs and sides indicates this condition and counts against the individual.

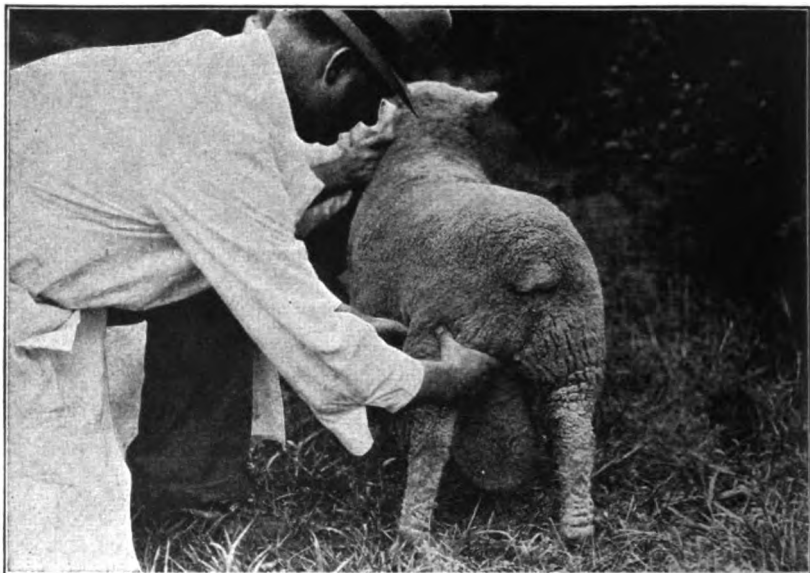


FIGURE 18.--Determining leg development.



FIGURE 19.—Examining the fleece and skin.

DETERMINING AGE OF SHEEP BY THE TEETH

It is important to be able to tell the approximate age of sheep by the teeth. Though it is not always possible to determine the exact

age in this way, a fairly close estimate can be made. A little practice will soon enable one to tell the age fairly well.

One good way to hold the head of the sheep and expose the teeth is shown in figure 21. The first and second fingers are placed on the lips, a slight pressure exerted, and the teeth exposed.

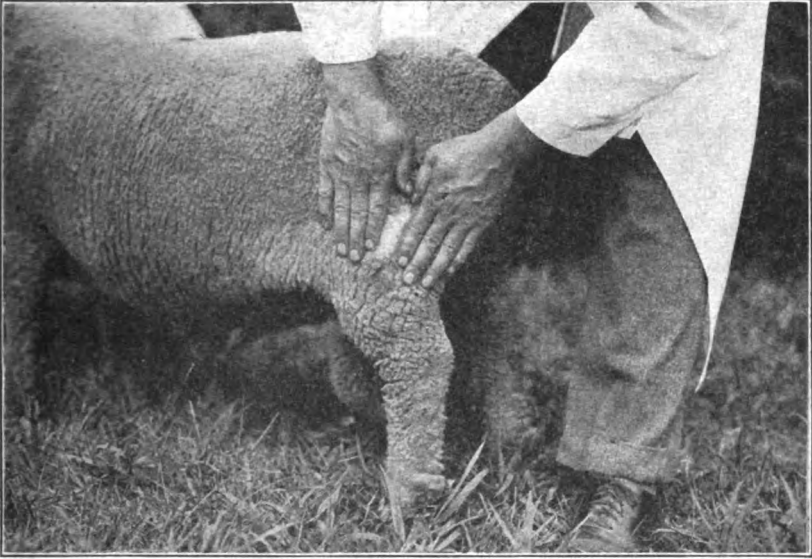


FIGURE 20.—Examining the fleece on the thigh.



FIGURE 21.—Lamb's mouth.



FIGURE 22.—Yearling's mouth.

A lamb mouth.—In a lamb all the baby teeth are present soon after birth. These teeth are small and are known also as the milk or lamb teeth (fig. 21).

Yearling mouth.—When the sheep is from about 12 to 14 months old, the two permanent front teeth, as shown in figure 22, come in. The milk teeth are seen at the side.

Two-year-olds' mouth.—At about 22 to 24 months, another pair of permanent teeth comes in, one on each side of the front pair (fig. 23).

Three-year-olds' mouth.—The third pair of permanent teeth comes in at about 34 to 36 months, one on each side of the first two pairs (fig. 24).



FIGURE 23.—Mouth of 2-year-old sheep.



FIGURE 24.—Mouth of 3-year-old sheep.

Full or 4-year-olds' mouth.—At about 46 to 48 months of age a sheep has a full mouth with all its permanent teeth present. From then on only an estimate of the age can be made from the mouth.



FIGURE 25.—Full or 4-year-olds' mouth.



FIGURE 26.—Broken mouth, aged sheep.

As a sheep grows older the teeth gradually spread and become shorter with wear (fig. 25).

Broken mouth.—As sheep grow still older they gradually lose their teeth. A broken-mouth sheep has trouble in eating and should not be kept in the flock (fig. 26).

LOCATION OF MARKET CUTS IN CARCASS

In judging fat sheep the judge should have in mind the various market cuts and their relative importance. It should always be remembered that the market wants a well-finished carcass. The most valuable cuts come from the leg, loin, and ribs, the cheaper cuts from the shoulder, breast, and shank (fig. 27).

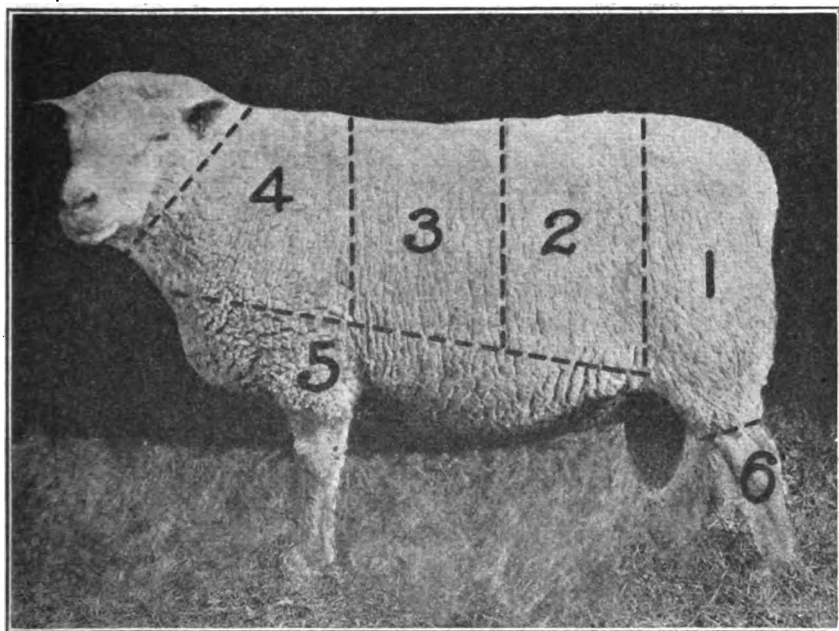


FIGURE 27.—Mutton and lamb cuts. Each half carcass is divided as shown: 1, Leg; 2, loin; 3, ribs; 4, shoulder; 5, breast; 6, shank.

The weight of a mutton carcass varies with the age, breed, and degree of fatness. The trade likes mature wethers to weigh 140 pounds. Lambs weighing about 80 to 85 pounds, in prime quality and condition usually sell at the highest market price.

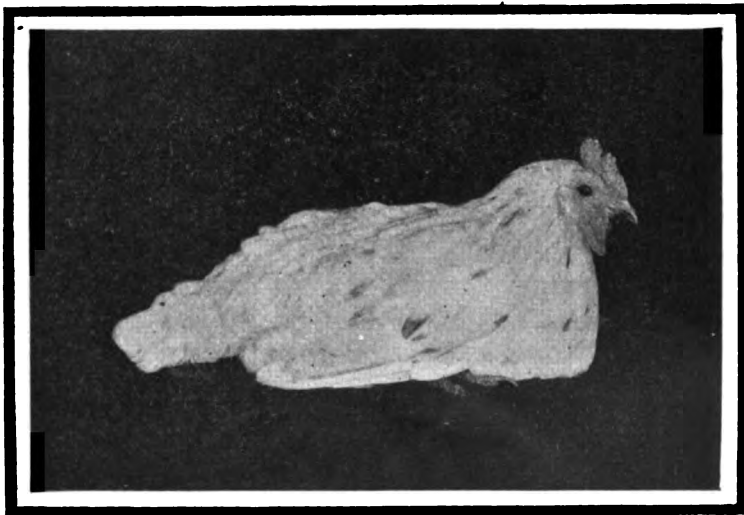
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TUBERCULOSIS OF FOWLS

BERNARD A. GALLAGHER
Pathological Division



A tuberculous fowl—an advanced case.

FARMERS' BULLETIN 1200

UNITED STATES DEPARTMENT OF AGRICULTURE

TUBERCULOSIS OF FOWLS is widely distributed over the United States.

It is especially destructive to flocks in the North and West.

The course of the disease is slow, symptoms are apparent only in the late stages, and the mortality is high.

Characteristic lesions are found in the internal organs of affected fowls, and are easily recognized.

Treatment of affected fowls is useless, but the disease may be stamped out by methods which are given in this publication.

Contribution from the Bureau of Animal Industry

JOHN R. MOHLER, Chief

Washington, D. C.

Issued June, 1921

TUBERCULOSIS OF FOWLS.

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OCCURRENCE OF THE DISEASE.

TUBERCULOSIS OF FOWLS is a chronic, infectious disease characterized by the formation of tubercles or nodules, and resembling tuberculosis of other animals and man. It is commonly called spotted liver, liver complaint, or rheumatism. Affected birds are also described as "going light."

The disease has been observed in many species of birds, among which may be mentioned the fowl, turkey, pigeon, duck, goose, guinea fowl, peafowl, ostrich, parrot, canary, pheasant, sparrow, and swan. Among wild birds it is most destructive to those confined in zoological gardens.

Of domesticated birds the fowl shows by far the highest mortality from tuberculosis. The disease is known to prevail in many countries and is widely distributed in the United States. It has spread so extensively in some States as to cause very serious losses to the poultry industry.

The insidious manner of attack makes tuberculosis most difficult to combat, because in affected birds there are no visible symptoms until the disease processes are far advanced, and in the meantime the bird may be spreading the disease among others of the flock.

CAUSE OF TUBERCULOSIS.

Tuberculosis of fowls, known also as avian tuberculosis, is caused by the *Bacillus tuberculosis avium*, a microorganism which closely resembles the bacilli of human and bovine tuberculosis. While the avian tubercle bacillus primarily affects birds, it may also attack other animals. Pigs exposed to tuberculous flocks frequently become infected and display localized tubercles in the lymph glands of the head, neck, and mesentery. Rats and mice may also contract the disease naturally. Avian tuberculosis has been produced experimentally by feeding or inoculation in pigs, calves, colts, goats, rabbits,

guinea pigs, monkeys, rats, and mice. Bacilli of the avian type have been found on several occasions in tuberculous persons. The danger to man, however, is very slight, especially since cooking the flesh of fowls destroys the bacilli. The principal danger would be the eating of raw eggs from tuberculous fowls; but as eggs are only occasionally infected, and as man is naturally highly resistant to the avian type of tubercle bacilli, the chances of the development of infection are considered slight. From a hygienic standpoint only birds, pigs, rats, and mice occupy a significant position in natural susceptibility to avian tuberculosis.

Birds have been infected artificially with mammalian types of tubercle bacilli; but with the exception of parrots and canaries, which are quite susceptible, birds are strongly resistant to human and bovine types of tubercle bacilli through natural channels of infection.

HOW BIRDS BECOME INFECTED.

The tubercle bacilli enter the fowl's body through the mouth and pass into the alimentary tract. They are picked up in drinking and feeding, and through the bird's eating of the carcass of another fowl that died of tuberculosis. The organisms pass from the intestinal canal into the wall of the intestine and are carried to the liver with the food material absorbed in the intestine. Their passage from the liver to other organs is principally by means of the blood stream.

Tubercle bacilli may be introduced on a farm or poultry establishment in a number of ways. Among these are the addition to the flock of fowls from an infected flock, exposure to a neighboring infected flock ranging over the same ground, infection of the premises by free flying birds, especially pigeons from infected flocks, and carriers, such as man or animals, whose shoes or feet may carry infected droppings from a near-by farm. Tubercle bacilli are sometimes found in eggs from tuberculous fowls and there is a possibility of introducing infection in eggs obtained for hatching. However, most eggs that harbor this organism fail to hatch, and thereby reduce to a minimum the chances of infection by this means. If such infected eggs are thrown to the chickens, however, the disease may become established in the flock.

Once avian tuberculosis is introduced on a premises it spreads slowly but persistently, until by the time its presence becomes apparent a large percentage of the flock may be affected, although only a few birds may show symptoms and deaths occur only at intervals. The extent to which affected birds spread infection depends upon the stage the lesions have reached in individuals. The outlet for the tuberculous organisms is principally through the intestinal canal by means of the droppings. The bacilli are given off in great numbers from the ulcerated areas in the intestinal wall and from the nodules

on the intestine which open into the intestinal canal through small channels. It is also probable that bacilli may pass from the liver through the bile ducts.

In the earlier stages of disease the organisms are held back by the protective wall of the nodules, but when extensive tubercles are formed by successive infections or by spread of the infection through the system, these nodules are broken down, and the inclosed masses of bacilli which continue to multiply in the nodules are released. Therefore it is the older fowls which have harbored tuberculosis for months, or even one or two years and are badly diseased, which give off infection to the greatest degree, and hence are the most dangerous to uninfected birds.

The disease-laden droppings contaminate the floors of the houses, the ground, and feeding and drinking vessels. The organisms thus spread are readily picked up by healthy fowls in feeding and drinking, and in the course of time practically the entire flock may be affected. Individual birds show varying degrees of resistance, however, and in some tuberculous flocks a few birds may remain free of disease or show only minor lesions. As a rule, though, if exposure is great, infection is equally extensive and the mortality is high.

SYMPTOMS.

Although the birds may become infected at any age, the disease is not readily detected by ordinary observation in those under 1 year old, owing to the fact that a number of months are required for the tubercle bacilli in the system to multiply sufficiently to interfere in a marked degree with the normal functions of the body. Hence it is the older fowls, those from 2 to 3 years old, which are most likely to display noticeable symptoms of disease and show a high death rate.

One of the first symptoms exhibited is gradual emaciation, which becomes especially noticeable in the breast muscles. These diminish in size until in advanced cases there is scarcely any flesh left on the breastbone. Feeling the breast region with the fingers will readily detect this wasting of the muscles. Loss of weight proceeds with emaciation and is very marked in the late stages of the disease. The appetite continues good. There is no rise in temperature, a normal range of from 106° to 108° F. being maintained until shortly before death, when the temperature drops several degrees.

Lameness in one or both legs, or drooping of one or both wings, is often observed, and may be the first symptom seen. These result from the development in joints of the legs or wings of tubercle bacilli, which cause painful swellings. The swellings may break down and discharge a cheesy material.

As the disease advances, the comb, wattles, skin of the head, and membranes in the mouth and about the eyes become pale. The eye

itself remains bright. The feathers are ruffed. The bird grows listless, weak, moves about little and is easily caught. Diarrhea, with greenish or yellowish droppings, leads to complete exhaustion.

Deaths in the flock occur at intervals. Affected birds may live only a short time after symptoms are noticed, or they may live for weeks. This depends to a large extent on the stage reached by the disease before the attention of the owner is attracted to the condition of the fowl. The course of tuberculosis is indefinite, however, and may be shorter in flocks where infection is widespread and consequently heavier than in mildly or newly infected flocks. Its course may run well over a year from the time the individual is infected.

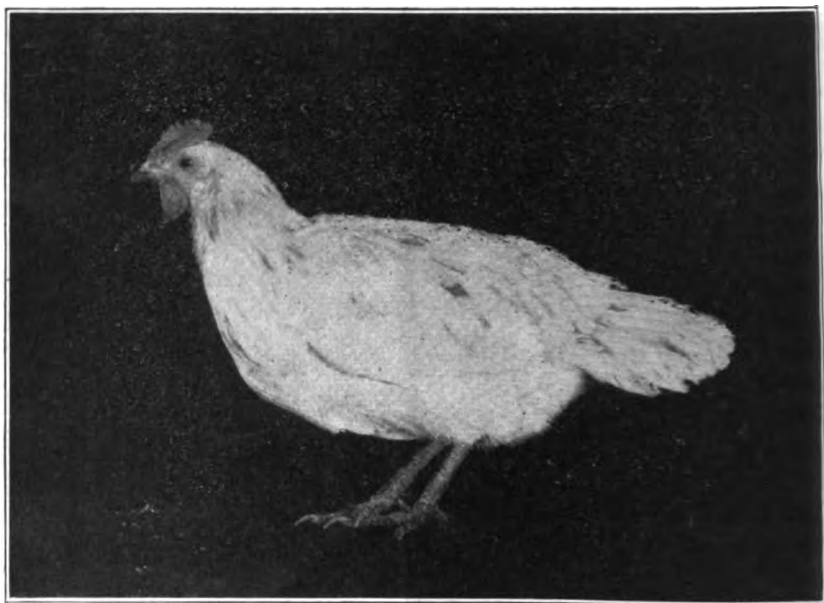


FIG. 1.—Tuberculous fowl, showing paleness of the head, ruffed feathers, swelling of the joints of the feet, and weakness. Advanced stage of the disease.

POST-MORTEM APPEARANCE.

Tuberculosis in fowls is manifested internally by tumors or tubercles in various parts of the body. These tubercles represent an attempt on the part of the bird's protective forces to wall off the invading microorganism and prevent its multiplication and spread throughout the system. The tuberculous lesions are primarily associated with the digestive system, and secondarily with other organs of the abdominal cavity, and body tissues. The lungs are not affected to the extent observed in tuberculosis of mammals.

The organs most frequently involved stand approximately in the following order: Liver, spleen, intestines, lungs, bones, joints, peritoneum, kidneys, and ovary. Lymphatic glands are few in birds and

Tuberculosis of Fowls.

therefore do not command the importance attached to them in tuberculosis of other animals.

The liver of an affected bird nearly always shows extensive lesions. The nodules are of varying sizes, the smaller ones having a white or grayish-white color, while the larger, more advanced ones assume a yellowish tinge. These tubercles are readily observed on the surface of the liver, and when the latter is sliced are also seen to be numerous in the interior. Extensive degenerated areas may be present. The liver is usually enlarged, sometimes to a marked degree. It may be pale in color and easily torn when handled. Not infrequently tuberculous fowls die from internal hemorrhage as a result of rupture of the degenerated liver.

The spleen is affected almost as often as the liver and presents much the same diseased appearance. It also is greatly enlarged, in

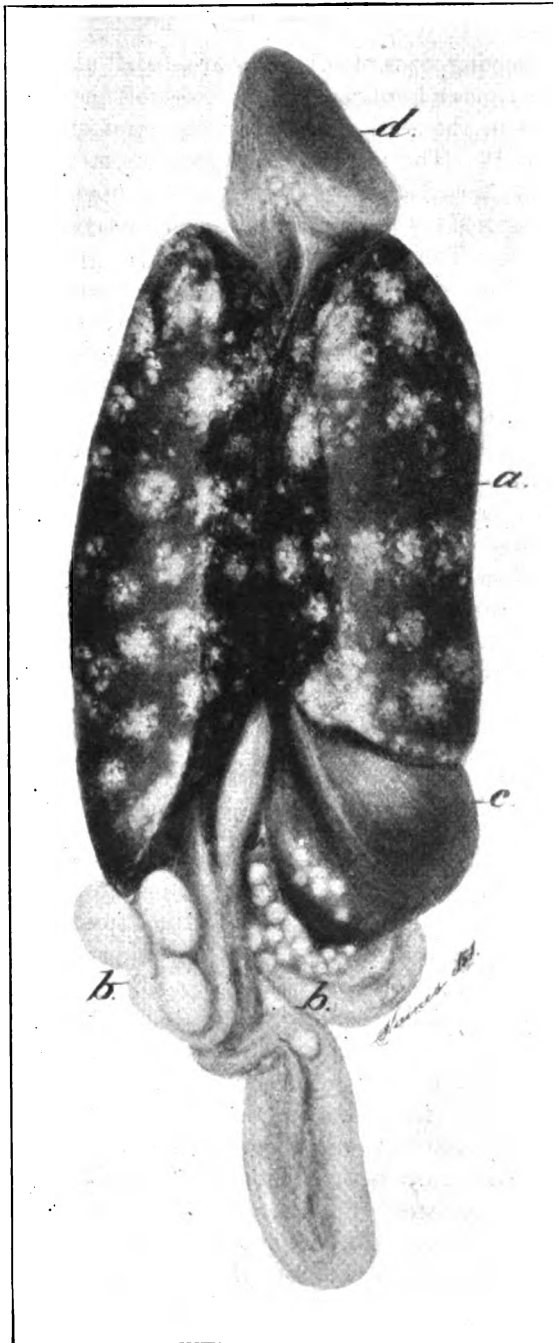


FIG. 2.—Internal organs of fowl showing typical tuberculous lesions: (a) liver, (b) intestine, (c) gizzard, and (d) heart.

many cases, even more so in proportion to its normal size than the liver.

Varying sizes of tubercles are distributed over the intestine, giving it at times a knotty surface. Nodules occur in the mucous membrane, deep in the wall of the intestine, and in the membrane which supports it. The lesions in the mucous membrane are often ulcerated, while the deeper ones frequently open into the intestinal canal through short channels and discharge enormous numbers of tubercle bacilli. The nodules ordinarily range in size from a pinhead to a pea, but may grow to an inch in diameter. They are firm to the touch and grayish white or yellowish in color.

Tuberculous changes are observed irregularly in the lungs, bones, and joints, peritoneum, kidneys, ovary, and other organs or parts. Usually one or more of the organs mentioned show lesions in individual cases, and each is affected in from 10 to 30 per cent of all cases. The tubercles are similar to those previously described. They tend to remain isolated and are easily separated from the tissues. Bone lesions are found principally at the joints. These show swelling, erosions, and accumulation of cheesy material.

Avian tubercles when cut open present a solid, grayish, glistening interior which in the larger ones exhibits yellowish centers or a number of yellowish points. Those of more advanced growth show extensive yellowish, cheesy, or crumbly masses in their interior, but do not develop into the gritty state familiar in mammalian tuberculosis.

TELLING TUBERCULOSIS FROM OTHER DISEASES.

The diseases which may be confused with tuberculosis of birds by similarity of lesions are: Tumors or cancers of the abdominal organs, tapeworm nodules in the intestine, fungous condition of the lungs, blackhead of turkeys, blood poisoning which produces an enlarged, spotted liver or gouty swellings of the joints. These diseases will not be considered in detail here since they are described in *Farmers' Bulletin 957*, a copy of which may be had on request. In general it may be said that the prominent lesions of the conditions mentioned are usually limited to certain specific organs instead of being spread to the variety of organs attacked in tuberculosis.

Tumors may be found in various parts of the body, but are usually few in number and considerably larger than tuberculous nodules. They generally contain blood vessels, while tuberculous growths are free from them. Tumors often degenerate and present dead, bloody areas.

Tapeworm nodules are confined to the intestinal wall and, as the description indicates, are caused by tapeworms in the intestine.

Nodules of fungous origin are found in the lungs and air sacs and only occasionally spread to other organs by immediate contact.

They are caused by certain molds and often are associated with a greenish growth in the air passages.

In blackhead of turkeys the liver and the ceca, or blind pouches of the intestine, are affected. The liver lesions are yellowish or greenish in color, but do not show the characteristic tubercle formation of tuberculosis.

Blood-poisoning diseases may produce yellow, decaying areas in the liver and spleen, accompanied with enlargements of these organs. There is, however, no nodular formation; the intestine is usually inflamed, and the heart may show hemorrhages on its wall.

In gout the joints may be swollen with pronounced lameness but without internal lesions resembling tuberculosis.

A definite diagnosis may be had in all cases by microscopic examination of the disease processes. Avian tubercles contain extremely numerous tuberculosis organisms which are readily seen in a laboratory examination.

TESTING FOWLS FOR TUBERCULOSIS.

Diagnosing tuberculosis in living fowls is possible by means of the intradermic tuberculin test. The test fluid used is prepared from bouillon in which avian-tubercle bacilli have grown for several weeks. The fluid must be injected, by means of a small-caliber syringe with a 26 or 27 gauge needle, into the deeper layer of the skin of the wattle or comb. It is preferable to inject both wattle and comb for greater accuracy. Slightly less than one drop, about one-twentieth of a cubic centimeter, is forced into the skin just beneath the surface, and not deep enough to penetrate the skin into the underlying connective tissue of the wattle or comb. Only one wattle is injected, the other being left for comparison. At the end of 48 hours following injection, a swelling in the wattle or comb indicates a positive reaction and the presence of tuberculosis in the fowl. A high percentage of tuberculous fowls in a flock may be detected by this test, but much of its success depends on the skill of the operator in placing the tuberculin properly within the skin tissues and in observing the results. Practice in the operation increases the efficiency of the test.

PREVENTION.

Medical treatment of tuberculosis in fowls is futile; hence measures for combating the disease must be of a preventive nature. The most thorough method of eradication is to slaughter the entire flock when indications point to an extensive outbreak. Fowls in good flesh, showing no lesions or slight ones, may be used for food. Those badly diseased and all visceral organs should be destroyed.

The chicken houses, inclosed runs, and all eating, drinking, and other utensils should be thoroughly cleaned and disinfected with

a strong solution of such germicides as carbolic acid, cresol, bichlorid of mercury, formaldehyde, or any of the recognized coal-tar preparations or dips. Carbolic acid may be used in 5 per cent solution, compound cresol in 3 per cent solution, bichlorid of mercury in a solution of 1 part to 500 parts of water, and formaldehyde in the proportion of 1 part of commercial formalin to 10 parts of water. Ordinary quicklime is a good, cheap disinfectant for poultry yards.

In disinfecting houses or yards merely sprinkling the germicide here and there is of little value. The liquids should be sprayed or otherwise applied in a thorough manner, so that the area to be disinfected is well soaked. After disinfection the premises should be kept free of fowls for several months, or a year if possible, so that any germs not reached by the disinfectant may die. If convenient it is advisable to place new stock on ground which has not been occupied by poultry for a year or more. The sun's rays will destroy organisms exposed to them in a short time, and by this means fields and yards are disinfected to a large extent. There are many dark or covered places not reached by the direct rays of the sun, however, and in such spots the germs of tuberculosis may survive for several months.

It is highly important in restocking to obtain fowls, or eggs for hatching, from flocks which have shown no evidence of the presence of an infectious disease for at least a year. Also, as a general principle when introducing fowls into a healthy flock, the new birds should be quarantined for at least a month in order to give time for the development of symptoms of any of the more acute diseases which may be carried.

When the breeding value of the fowls or other interests make it undesirable to dispose of the entire flock, tuberculosis may be controlled and even eradicated by other measures if consistently practiced. As has been stated, the disease develops very slowly as a rule and affected birds do not spread the bacilli in the droppings until the internal lesions are far advanced. Fowls more than 2 years old show the highest per cent of infection and the most advanced lesions and they are most dangerous as spreaders of tuberculosis. For this reason it is advisable to dispose of all birds when they reach the age of 2 years, or at the end of the second laying period. From an economic standpoint also this is sound policy, as the egg yield decreases after the second year of laying. Younger birds should be disposed of whenever they appear to be abnormal. This procedure alone will go a long way in holding tuberculosis in check, and will keep the losses to a minimum, although it may not be depended on to eradicate the disease completely.

Much more effective control or complete eradication may result by supplementing the culling measures with the tuberculin test already described. While this test can not be depended upon to

detect every tuberculous fowl, the large percentage which may be detected by its skillful application warrants its use as an important aid in eradication measures. After a period of several months the flock should be tested again in order to discover new cases of tuberculosis, or cases which failed to react to the first test. The percentage of reactors to the second test should be very small. All birds showing positive or doubtful reactions should be disposed of after each test.

Diseased carcasses should never be thrown where chickens can pick at them, as there is much greater danger of severe infection from eating the tuberculous organs of a dead fowl than from other sources. Neither should carcasses be thrown to hogs, as those animals are susceptible to avian tuberculosis. All carcasses should be burned or buried deep.

Since rats and mice may contract avian tuberculosis they may have an influence on the spread of infection caused by fowls eating the carcasses of rats dead of the disease. The destruction of rats and mice guards against this avenue of infection.



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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1200

TUBERCULOSIS OF FOWLS



TUBERCULOSIS OF FOWLS is widely distributed over the central and north-central portion of the United States.

It is especially destructive to flocks in that section.

The course of the disease is slow, symptoms are apparent only in the late stages, and the mortality is high in old birds.

Characteristic lesions are found in the internal organs of affected fowls, and are easily recognized.

Treatment of affected fowls is useless, but the disease may be stamped out by methods which are given in this publication.

Washington, D. C.

Issued June, 1921; revised May, 1931.

TUBERCULOSIS OF FOWLS

By **BERNARD A. GALLAGHER**, *Pathological Division, Bureau of Animal Industry*¹

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OCCURRENCE OF THE DISEASE

Tuberculosis of fowls is a chronic, infectious disease characterized by the formation of tubercles or nodules, and

Of domesticated birds, mature chickens show by far the highest mortality from tuberculosis. The disease is known to prevail in many countries and is widely distributed in the cen-

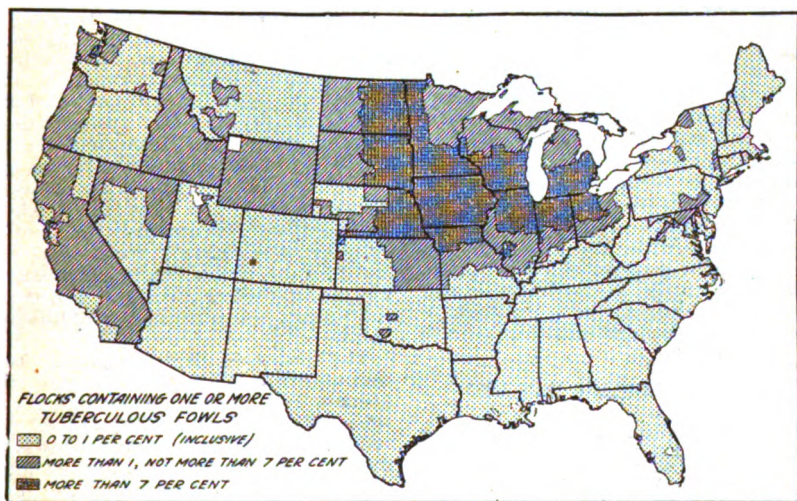


FIGURE 1.—Approximate extent of avian tuberculosis in the United States

resembling tuberculosis of other animals and man. It is commonly called spotted liver, liver complaint, or rheumatism. Affected birds are also described as “going light.”

The disease has been observed in many species of birds, among which may be mentioned the chicken, turkey, pigeon, duck, goose, guinea fowl, peafowl, ostrich, parrot, canary, pheasant, sparrow, and swan. Among wild birds it is most destructive to those confined in zoological gardens.

tral and north-central part of the United States. (Fig. 1.) It has spread so extensively in some States as to cause very serious losses to the poultry and swine industries.

The insidious manner of attack makes tuberculosis most difficult to combat, because in affected birds there are no visible symptoms until the disease processes are far advanced, and in the meantime the bird may be spreading the disease among others of the flock.

¹ Doctor Gallagher resigned Mar. 5, 1924.
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CAUSE OF TUBERCULOSIS

Tuberculosis of fowls, known also as avian tuberculosis, is caused by the *Mycobacterium tuberculosis avium*, a microorganism which closely resembles the bacilli of human and bovine tuberculosis. While the avian tubercle bacillus primarily affects birds, it may also attack other animals. Pigs exposed to tuberculous flocks frequently become infected and display localized tubercles in the lymph glands of the head, neck, and mesentery. Rats and mice may also contract the disease naturally. Avian tuberculosis has been produced experimentally by feeding or inoculation in pigs, calves, colts, goats, rabbits, guinea pigs, monkeys, rats, and mice. Bacilli of the avian type have been found on several occasions in tuberculous persons. The danger to man, however, is very slight, especially since cooking the flesh of fowls destroys the bacilli. The principal danger would be the eating of raw eggs from tuberculous fowls; but as eggs are only occasionally infected, and as man is naturally highly resistant to the avian type of tubercle bacilli, the chances of the development of infection are considered slight. From a hygienic standpoint, only birds, pigs, rats, and mice occupy a significant position in natural susceptibility to avian tuberculosis.

Birds have been infected artificially with mammalian types of tubercle bacilli; but with the exception of parrots and canaries, which are quite susceptible, birds are strongly resistant to human and bovine types of tubercle bacilli through natural channels of infection.

HOW BIRDS BECOME INFECTED

The tubercle bacilli enter the fowl's body through the mouth and pass into the alimentary tract. They are picked up in drinking and feeding, and through the bird's eating of the carcass of another fowl that died of tuberculosis. The organisms pass from the intestinal canal into the wall of the intestine and are carried to the liver with the food material absorbed in the intestine. Their passage from the liver to other organs is principally by means of the blood stream.

Tubercle bacilli may be introduced on a farm or poultry establishment in a number of ways. Among these are the addition to the flock of fowls from an infected flock, exposure to a neighboring infected flock ranging over the

same ground, infection of the premises by free flying birds, especially pigeons from infected flocks, and carriers, such as man or animals, whose shoes or feet may carry infected droppings from a near-by farm.

Once avian tuberculosis is introduced on the premises it spreads slowly but persistently, until by the time its presence becomes apparent a large percentage of the flock may be affected, although only a few birds may show symptoms and deaths occur only at intervals. The extent to which affected birds spread infection depends upon the stage the lesions have reached in individuals. The outlet for the tuberculous organisms is principally through the intestinal canal by means of the droppings. The bacilli are given off in great numbers from the ulcerated areas in the intestinal wall and from the nodules on the intestine, which open into the intestinal canal through small channels. It is also probable that bacilli may pass from the liver through the bile ducts.

In the earlier stages of disease the organisms are held back by the protective wall of the nodules, but when extensive tubercles are formed by successive infections or by spread of the infection through the system, these nodules are broken down, and the inclosed masses of bacilli which continue to multiply in the nodules are released. Therefore it is the older fowls which have harbored tuberculosis for months, or even one or two years, and are badly diseased, which give off infection to the greatest degree, and hence are the most dangerous to uninfected birds.

The disease-laden droppings contaminate the floors of the houses, the ground, and feeding and drinking vessels. The organisms thus spread are readily picked up by healthy fowls in feeding and drinking, and in the course of time practically the entire flock may be affected. Individual birds show varying degrees of resistance, however, and in some tuberculous flocks a few birds may remain free of disease or show only minor lesions. As a rule, though, if exposure is great, infection is equally extensive and the mortality is high.

SYMPTOMS

Although the birds may become infected at any age, the disease is not readily detected by ordinary observation in those under 1 year old, owing to the fact that a number of months

are required for the tubercle bacilli in the system to multiply sufficiently to interfere in a marked degree with the normal functions of the body. Hence it is the older fowls, those from 2 to 3 years old, which are most likely to display noticeable symptoms of disease and show a high death rate.

One of the first symptoms exhibited is gradual emaciation, which becomes especially noticeable in the breast muscles. These diminish in size until in advanced cases there is scarcely any flesh left on the breastbone.

branes in the mouth and about the eyes become pale. The eye itself remains bright. The feathers are ruffled. (Fig. 2.) The bird grows listless, weak, moves about little, and is easily caught. Diarrhea, with greenish or yellowish droppings, leads to complete exhaustion.

Deaths in the flock occur at intervals. Affected birds may live only a short time after symptoms are noticed or they may live for weeks. This depends to a large extent on the stage reached by the disease before the

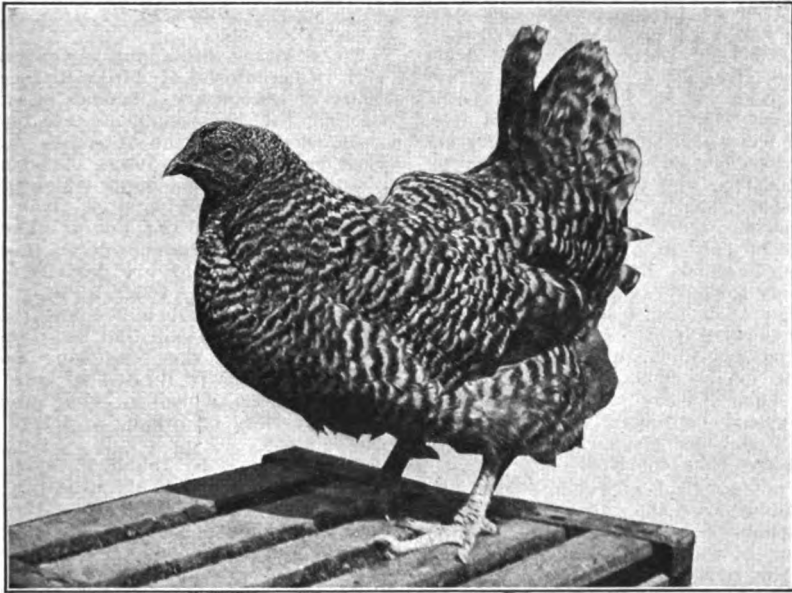


FIGURE 2.—Tuberculous fowl, showing ruffled feathers, swelling of the joints of the feet, and weakness. Advanced stage of the disease

Feeling the breast region with the fingers will readily detect this wasting of the muscles. Loss of weight proceeds with emaciation and is very marked in the late stages of the disease. The appetite continues good. There is no rise in temperature, a normal range of from 106° to 108° F. being maintained until shortly before death, when the temperature drops several degrees.

Lameness in one or both legs, or drooping of one or both wings, is often observed, and may be the first symptom seen. These result from the development in joints of the legs or wings of tubercle bacilli, which cause painful swellings. The swellings may break down and discharge a cheesy material.

As the disease advances, the comb, wattles, skin of the head, and mem-

attention of the owner is attracted to the condition of the fowl. The course of tuberculosis is indefinite, however, and may be shorter in flocks where infection is widespread, and consequently heavier than in mildly or newly infected flocks. Its course may run well over a year from the time the individual is infected.

POST-MORTEM APPEARANCE

Tuberculosis in fowls is manifested internally by tumors or tubercles in various parts of the body. These tubercles represent an attempt on the part of the bird's protective forces to wall off the invading microorganism and prevent its multiplication and spread throughout the system. The tuberculous lesions are primarily associated with the digestive system, and

secondarily with other organs of the abdominal cavity and body tissues. The lungs are not affected to the extent observed in tuberculosis of mammals.

The organs most frequently involved stand approximately in the following order: Liver, spleen, intestines, lungs, bones, joints, peritoneum, kidneys, and ovary. Lymphatic glands are few in birds, and therefore do not command the importance attached to them in tuberculosis of other animals.

The liver of an affected bird nearly always shows extensive lesions. (Fig. 3.) The nodules are of varying sizes, the smaller ones having a white or grayish-white color, while the larger, more advanced ones assume a yellowish tinge. These tubercles are readily observed on the surface of the liver, and when the latter is sliced are also seen to be numerous in the interior. Extensive degenerated areas may be present. The liver is usually enlarged, sometimes to a marked degree. It may be pale in color and easily torn when handled. Not infrequently tuberculous fowls die from internal hemorrhage as a result of rupture of the degenerated liver.

The spleen is affected almost as often as the liver and presents much the same diseased appearance. It also is greatly enlarged, in many cases even more so in proportion to its normal size than the liver.

Varying sizes of tubercles are distributed over the intestine, giving it at times a knotty surface. Nodules occur in the mucous membrane, deep in the wall of the intestine, and in the membrane which supports it. The lesions in the mucous membrane are often ulcerated, while the deeper ones frequently open into the intestinal canal through short channels and discharge enormous numbers of tubercle bacilli. The nodules ordinarily range in size from a pinhead to a pea, but may grow to an inch in diameter. They are firm to the touch and grayish white or yellowish in color.

Tuberculous changes are observed irregularly in the lungs, bones, and joints, peritoneum, kidneys, ovaries, and other organs or parts. Usually one or more of the organs mentioned show lesions in individual cases, and each is affected in from 10 to 30 per cent of all cases. The tubercles are similar to those previously described. They tend to remain isolated and are easily separated from the tissues. Bone lesions are found principally at

the joints. These show swelling, erosions, and accumulation of cheesy material.

Avian tubercles when cut open present a solid, grayish, glistening interior which in the larger ones exhibit yellowish centers or a number of yellowish points. Those of more advanced growth show extensive yellowish, cheesy, or crumbly masses in their interior but do not develop into the gritty state familiar in mammalian tuberculosis.

TELLING TUBERCULOSIS FROM OTHER DISEASES

The diseases which may be confused with tuberculosis of birds by similarity of lesions are: Tumors or cancers of the abdominal organs, tapeworm nodules in the intestine, fungous condition of the lungs, blackhead of turkeys, blood poisoning which produces an enlarged, spotted liver or gouty swelling of the joints. These diseases will not be considered in detail here, since they are described in *Farmers' Bulletin 1652*, a copy of which may be had on request. In general it may be said that the prominent lesions of the conditions mentioned are usually limited to certain specific organs instead of being spread to the variety of organs attacked in tuberculosis.

Tumors may be found in various parts of the body but are usually few in number and considerably larger than tuberculosis nodules. They generally contain blood vessels, while tuberculous growths are free from them. Tumors often degenerate and present dead, bloody areas.

Tapeworm nodules are confined to the intestinal wall and, as the description indicates, are caused by tapeworms in the intestine.

Nodules of fungous origin are found in the lungs and air sacs and only occasionally spread to other organs by immediate contact. They are caused by certain molds and often are associated with a greenish growth in the air passages.

In blackhead of turkeys the liver and the ceca, or blind pouches of the intestine, are affected. The liver lesions are yellowish or greenish in color, but do not show the characteristic tubercle formation of tuberculosis.

Blood-poisoning diseases may produce yellow, decaying areas in the liver and spleen, accompanied with

enlargements of these organs. There is, however, no nodular formation; the intestine is usually inflamed, and the heart may show hemorrhages on its wall.

In gout the joints may be swollen with pronounced lameness but without internal lesions resembling tuberculosis.

A definite diagnosis may be had in all cases by microscopic examination of the disease processes. Avian tubercles contain extremely numerous tuberculosis organisms which are readily seen in a laboratory examination.

TESTING FOWLS FOR TUBERCULOSIS

Diagnosing tuberculosis in living fowls is possible by means of the intradermic tuberculin test. The test fluid used is prepared from bouillon in which avian-tubercle bacilli have grown for several weeks. The fluid must be injected, by means of a small-caliber syringe with a 26 or 27 gage needle, into the deeper layer of the skin of the wattle or comb. It is preferable to inject both wattle and comb for greater accuracy. Slightly less than one drop, about one-twentieth of a cubic centimeter, is forced into the skin just beneath the surface, and not deep enough to penetrate the skin or enter the underlying connective tissue of the wattle or comb. Only one wattle is injected, the other being left for comparison. At the end of 48 hours following injection, a swelling in the wattle or comb indicates a positive reaction and the presence of tuberculosis in the fowl. A high percentage of tu-

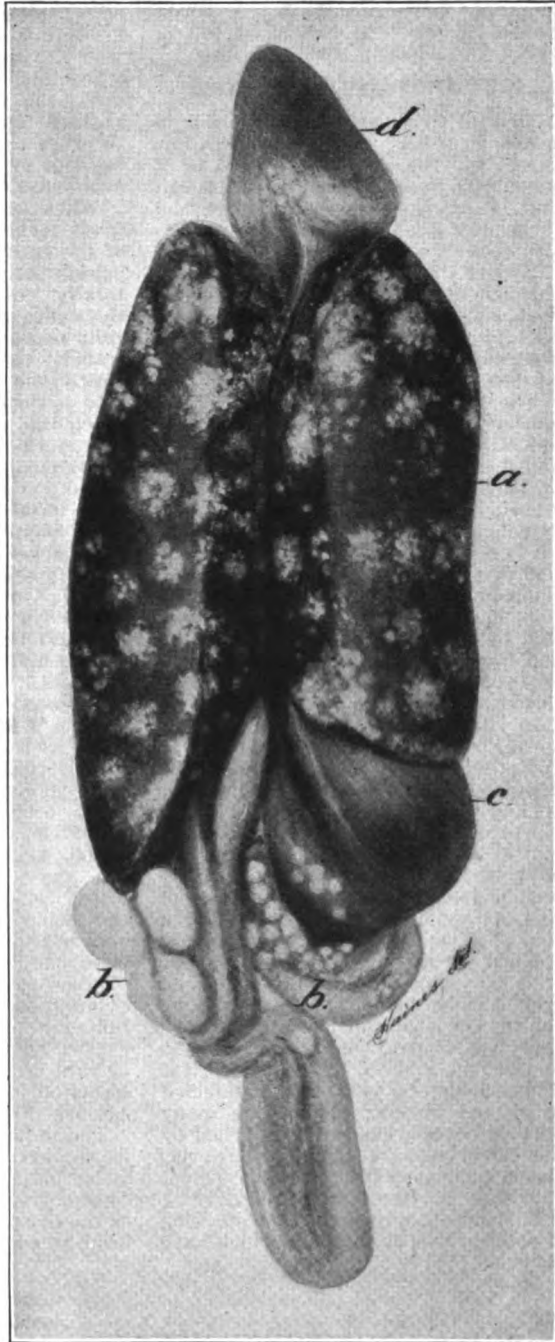


FIGURE 3.—Internal organs of fowl, showing typical tuberculosis lesions of (a) liver, (b) intestine, (c) gizzard, and (d) heart

berculous fowls in a flock may be detected by this test, which should be applied by a qualified veterinarian.

PREVENTION AND ERADICATION

Medical treatment of tuberculosis in fowls is futile; hence measures for combating the disease must be of a preventive nature. The most thorough and therefore most desirable method of eradication is to slaughter the entire flock when indications point to the extensive presence of the disease throughout the flock. Fowls in good flesh, showing no lesions or slight ones, may be used for food. Those badly diseased and all visceral organs should be destroyed.

The chicken houses, inclosed runs, and all eating, drinking, and other utensils should be thoroughly cleaned and disinfected with a strong solution of such germicides as carbolic acid, cresol, bichloride of mercury, formaldehyde, or any of the recognized coaltar preparations or dips. Carbolic acid may be used in 5 per cent solution, compound cresol in 3 per cent solution, bichloride of mercury in a solution of 1 part to 500 parts of water, and formaldehyde in the proportion of 1 part of commercial formalin to 10 parts of water.

In disinfecting houses or yards merely sprinkling the germicide here and there is of little value. The liquids should be sprayed or otherwise applied in a thorough manner, so that the area to be disinfected is well soaked and this done only after the most thorough cleaning. After disinfection the premises should be kept free of fowls for several months, or a year if possible, so that any germs not reached by the disinfectant may die. It is advisable to place new stock on ground which has not been occupied by poultry for a year or more. The sun's rays will destroy organisms exposed to them in a short time, and by this means fields and yards are disinfected to a large extent. There are many dark or covered places not reached by the direct rays of the sun, however, and in such spots the germs of tuberculosis may survive for several months.

It is highly important in restocking to obtain fowls from flocks which have

shown no evidence of the presence of an infectious disease for at least a year. Also, as a general principle when introducing fowls into a healthy flock, the new birds should be quarantined for from 10 days to a month in order to give time for the development of symptoms of any of the more acute diseases which may be carried.

When the breeding value of the fowls makes it undesirable to dispose of the entire flock by slaughter, tuberculosis may be controlled and even totally eradicated by supplementing the culling measures with the tuberculin test and sanitation. As has been stated, the disease develops very slowly and for that reason it is advisable to dispose of all birds when they reach the age of 1½ years, or at the end of the first laying period. From an economic standpoint also this is sound policy, as the egg yield decreases after the first year of laying. Younger birds should be disposed of whenever they appear to be abnormal. This procedure alone will greatly assist in holding tuberculosis in check. The house, yard, and equipment should be thoroughly cleaned and disinfected and the flock moved to new quarters.

Diseased carcasses should never be thrown where chickens can pick at them, as there is much greater danger of severe infection from eating the tuberculous organs of a dead fowl than from other sources. All carcasses should be burned or buried deep and not thrown to hogs, as those animals are very susceptible to fowl tuberculosis. A considerable percentage of the swine found to have tuberculosis appear to have contracted the disease from poultry.

Since rats and mice may contract avian tuberculosis they may have an influence on the spread of infection caused by fowls eating the carcasses of rats dead of the disease. The destruction of rats and mice guards against this avenue of infection.

The importance of fowl tuberculosis in connection with the poultry and swine industries makes it advisable to consult frequently a local veterinarian or the livestock sanitary officials of the State in which the flock belongs.

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